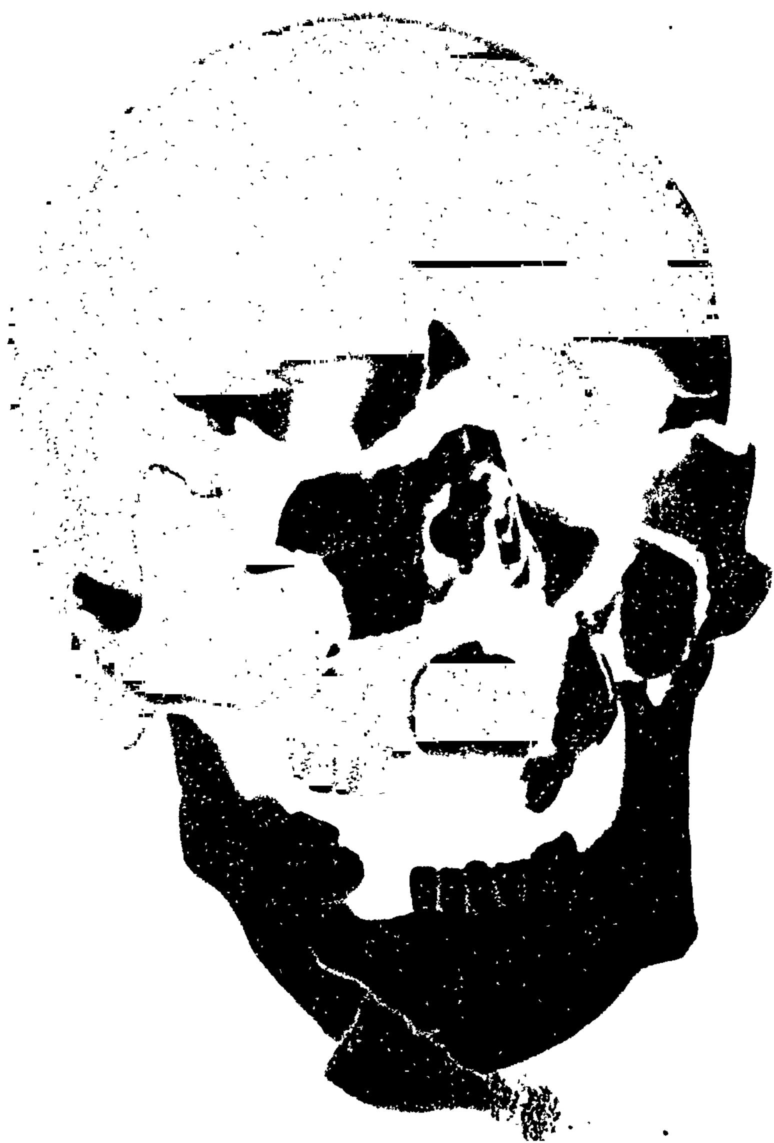


TRAUMATIC INJURIES OF FACIAL BONES

AN ATLAS OF TREATMENT

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FOREWORD

"TRAUMATIC Injuries of the Facial Bones", as presented by the authors arrives at a time when sound knowledge in the handling of these injuries is most needed. I am particularly impressed with the manner in which the subject matter is presented, and I think that one of the finest things is the way in which the book is illustrated...

The violence produced by our present methods of warfare shows high incidence in injuries of the face, and only too often we find the medical officer who must care for this type of injury poorly informed on the best methods. Here we have a compact manual which tells how to do the immediate thing. This leads to what should be done as a follow-through, and here plastic surgery comes into the picture. All in all, this book will be of great value to the ordinary practitioner of medicine and will also prove to be a fine guide to the young surgeon who is beginning his work in traumatic and plastic surgery.

The Medical Department of the Navy is especially grateful to the authors, for it will be of use to all naval surgeons. It is grateful to them, too, for the fine work they are now doing in instructing physicians and dentists in the principles of maxillofacial surgery.

Ross T. McIntire
Rear Admiral, MC, U.S.N.
The Surgeon General of the Navy.

Washington, D.C.

FOREWORD

THE accumulated knowledge and experience of the past few years in relation to the principles of plastic surgery have brought great advances in the art of restoration of form and function. The trend of these advances has been toward a growing recognition of the fact that the principles of plastic surgery are the same in whatever region of the body they need be applied. There is, therefore, a disposition in this country to follow the practice of other countries, notably Great Britain, and to broaden the scope of the work of plastic surgeons. They, with their special skill, are being called on to treat those deformities and defects encountered in the practice of general surgery and the surgical specialties, in correction of which mastery of the intricacies of plastic procedures is a prerequisite for the best results.

The principles of plastic surgery are best exemplified in the management of maxillofacial injuries and deformities, where the accomplishment of satisfactory results demands intelligent planning, perfect technic and exacting attention to every detail. The ability of maxillofacial surgeons to restore form and function seems to be almost limitless and the evidence of their powers, particularly in relation to war injuries, has led to the establishment of centers where intensive training is available. Dissemination of the knowledge and skill taught in these centers will contribute much to the efficient management of these injuries, both during the war and in the postwar period.

The plan of this book has been based on many requests from officers of the armed forces who have been assigned to the Mayo Foundation for training in maxillofacial surgery. These officers have urged Drs. Erich and Austin to publish their demonstrations of methods of dealing with fractures of the bones of the face. In doing so, the authors have given proper emphasis to the fact that many facial injuries involve structures in the repair of which the dental surgeon may well be concerned. This volume represents, therefore, a sincere effort to co-ordinate available knowledge and experience in solving the intricate problems encountered in the management of maxillofacial injuries and deformities and, as such, constitutes a real and timely contribution.

DONALD C. BALFOUR.

ROCHESTER, MINNESOTA.

PREFACE

WITH the decided increase in serious facial injuries that is resulting from present day methods of warfare, the treatment of traumatic injuries of the bones of the face is becoming more and more complex. The complexity is not being simplified by the mounting number of contradictory procedures being advocated in the literature for the management of such injuries. It is natural, of course, that opposing ideas concerning therapeutic measures should exist, since surgeons have approached, from divergent points of view, the problems that arise in care of injuries of facial bones. Plastic surgeons, general surgeons, otolaryngologists and dental surgeons all have proposed technics for the treatment of these injuries, and opinions never can be entirely in accord. Adding to the confusion of this subject is the lack of an orderly plan to be followed in care of the patient with fractures of all of the facial bones, a not uncommon war injury. Under such circumstances, one no longer can segregate the treatment into the management of individual fractures, because such fractures cannot be treated as a collection of unrelated traumatic defects. On the contrary, the treatment must be arranged so as to care for all of the facial bones as a structural unit.

These, then, are among the difficulties which beset the inexperienced person who must care for these injuries, often under trying and variable circumstances. It is our hope that this book will be serviceable to him as well as to the specialist in clarifying this subject. Our objective here is to present a simple but detailed discussion, in outline form, of at least one acceptable form of treatment for every type of fracture and defect involving the mandible, maxilla, malar bones and nasal bones; also to include, in a similar manner, an efficient method of treating every combination of fractures of facial bones which we have encountered. In addition, we wish to introduce an orderly sequence of procedures to be carried out in the care of patients with multiple fractures of all the facial bones as well as the ethmoid bone.

It is not our desire to present unalterable technics but rather to suggest principles and plans of therapy. Neither do we wish to convey the impression that the methods outlined in this book are superior to all others. The material offered here, some of which has been devised by ourselves, is a collection of procedures, which in our experience at the Mayo Clinic, have given the most satisfactory results with the fewest complications.

Too frequently does one hear of the "medical" or of the "dental" approach to the problems arising in the care of injuries of facial bones. We prefer to dispense with these terms and to think of the therapeutic measures in the light of efficiency rather than of whether they derive from medicine or dentistry. The most efficient method may not always be the shortest or simplest but it is without question the most desirable. There can be no doubt that close collaboration between the plastic surgeon, the otolaryngologist and the dental surgeon serves the best interests of the patient with injuries of facial bones.

In the months and years to come, some of the procedures outlined here will be supplanted by more effective methods. Constantly being proposed and devised are new technics, many of which will be found to surpass in efficiency those of today. Modern methods of treating traumatic injuries to the facial bones are far from being in a final stage of faultlessness. There is yet much opportunity for improvement.

JOHN B. ERICH,
LOUIE T. AUSTIN.

ROCHESTER, MINNESOTA.

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THIS volume owes its existence largely to the co-operation of the staffs of the Photographic Department, the Art Department, the Museum of Hygiene and Medicine, and the Instrument Shop of the Mayo Clinic. In particular, we wish to express our appreciation to Mr. L. A. Julin and Mr. S. J. McComb for the preparation of photographs, to Mr. Russel Drake for providing the necessary drawings, to Dr. A. H. Bulbulian for the construction of moulages, and to Mr. D. A. Rogers for the production of certain appliances and instruments. We also are grateful to Miss Valeria Kennedy and Miss Dorothy Follo for expert typing of the manuscript.

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Finally, this book could not have been accomplished without the encouragement, advice, knowledge and patient care in correcting and editing the manuscript furnished by the head of the Division of Publications of the Mayo Clinic, Dr. R. M. Hewitt. To him and his associate, Miss M. Katharine Smith, as well as to Miss Bereith Bandel, editorial assistant, and to Misses Shirley Netzke and Emogene Becker who read the proof, we are deeply indebted.

J. B. E.
L. T. A.

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John B. Erich,
Louie T. Austin.

Rochester, Minnesota.

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THE PLAN OF THIS BOOK

1. It seemed advisable to divide this book not only into chapters, but also into individual problems, under each of which the management of specific types of injuries of the facial bones is considered.

2. In general, the first page of a problem is headed "Comments," in which the important phases of the problem are considered. The succeeding pages present a detailed discussion, in brief form, of the methods of treatment which we believe are most effective and appropriate.

3. In so far as it was possible to do so, the reading material relating to each picture has been placed on the right hand page, opposite the corresponding illustration.

4. The reader will find considerable repetition. This is intentional to stress those items which deserve emphasis. Moreover, this volume was not designed to be read necessarily from cover to cover; instead, it has been prepared as a handbook, in a manner that, we hope, will enable the reader to obtain the essential information concerning each problem without perusal of an entire chapter or the complete book.

5. Illustrations, in all, number 333. However, to facilitate the reading of some of the problems and to reduce to a minimum the necessity of turning to other parts of the book, a few of these pictures appear two or three times.

6. In the first nine chapters, it is assumed that the reader is acquainted with the technical details of intra-oral and extraoral wiring, with the construction of plaster head caps and dental splints, and with the application of skeletal traction appliances. For those who are not familiar with these procedures, detailed information is available in the last three chapters. Throughout chapter I to IX inclusive, references repeatedly are made to the material in chapters X, XI and XII.

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CHAPTER I

GENERAL CONSIDERATIONS IN THE CARE OF INJURIES OF FACIAL BONES

THE aim to be attained in the treatment of traumatic injuries of the facial bones is restoration of occlusion of the teeth, of function of the jaws, and of symmetry and normality of facial contour. Not the least important is the last objective. There is no doubt that many facial deformities and subsequent plastic operations could be averted if more thought, time and care were devoted to management of the original injury. Unfortunately, the majority of poor cosmetic results can be directly attributed to ignorance or to hurried and not sufficiently careful surgical technic. Many persons do not appreciate the detrimental effect that posttraumatic facial defects have on the minds and emotions of most individuals. It is safe to assert that of all deformities, few are of more concern to patients than those involving the face or facial bones. Obviously, these facts should stimulate the surgeon's desire to give careful attention to every injury of facial bones, regardless of its apparent insignificance, in an effort to prevent or to minimize subsequent disfigurement.

Unless associated with a fracture of the ethmoid bone or of the skull, even severe injuries to the bones of the face are not usually destructive of life. Consequently, the first consideration in the care of the patient should not be the injuries of the facial bones but the patient's general condition. To be more specific, immediate treatment should consist in the diagnosis and management of shock, of hemorrhage, and of associated wounds of the body that are likely to cause death. Establishment of an adequate airway, also, should not be overlooked. The care of fractures and defects of facial bones is never urgent. As a matter of fact, we do not hesitate to defer treatment relative to these bones for three to four days following the injury, or even longer if desirable.

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ESTABLISHMENT OF AN AIRWAY

It is surprising how frequently the airway of a seriously injured, and particularly of a comatose, patient is disregarded or neglected. Injuries about the face and jaws, more than injuries in any other region, are likely to produce obstruction of the upper air passages. The tongue of an unconscious individual may fall back into the pharynx. In the presence of bilateral fractures of the anterior part of the mandible or of loss of the entire lower jaw, the patient may be unable to hold his tongue forward. Blood may accumulate in the hypopharynx until breathing is impossible. Compression injuries and deep lacerations in the anterior part of the neck may produce laryngeal edema sufficient to close off the airway. All such conditions should be sought for and remedied without delay. A suture or safety pin inserted in the tongue and taped to the chin will hold the tongue forward. Accumulation of blood in the pharynx can be prevented by turning the patient on his side with his head lowered. In some instances, an intratracheal tube may become necessary to maintain an airway, until tracheotomy can be performed.

ASSOCIATED INJURIES OF SOFT TISSUES OF THE FACE

While the management of injuries of facial bones is better deferred for a time (two or three days), wounds of soft tissues of the face should be treated within a few hours after the accident, provided the patient's general condition will tolerate use of the local anesthesia that is necessary in this form of reparative surgery. Without doubt, early repair of wounds of the soft facial tissues is distinctly advantageous. It stimulates prompt healing, limits the degree of inflammatory reaction and, in turn, minimizes subsequent development of scar tissue. Early treatment of facial lacerations does not imply employment of hasty or careless timesaving measures; in fact, it is better to defer treatment until sufficient time is available to permit of appropriate care of the wounds. We do not wish to discuss the treatment of wounds of soft tissues of the face except in so far as treatment may affect favorably or adversely the healing or treatment of injuries of the facial bones.

HEMORRHAGE AND SHOCK

The factors of prime importance in the immediate care of a patient with injuries of facial bones should be, then, the prompt control of hemorrhage and the undelayed treatment of shock.

Hemorrhages which result from facial wounds are never of great concern and can be checked with little difficulty by application of hemostats to bleeding vessels, or more often by the mere application of a pressure dressing to the wound. The treatment of hemorrhages which result from injured blood vessels in parts of the body other than the face is out of the realm of this book, but is of much significance. Furthermore, if patients are seriously injured, the possibility of intrathoracic or intra-abdominal bleeding should not be overlooked; hemorrhages from these sources not only involve loss of blood but also may produce a most dangerous form of shock.

Regardless of the location or type of injury, shock, a condition of depression of the vital activities of the body associated with a decided fall in blood pressure, is the immediate outcome of the accident. Depending on the type of wound inflicted, shock may vary from a slight form of dizziness and faintness to complete prostration and sometimes death. Because severe shock is perilous to the patient's life, this condition always should be considered and treated immediately, whether the primary injury involves the bones of the face or any other region of the body. The symptoms of shock are well known: a weak pulse becoming irregular and rapid, a pale countenance covered with perspiration, a slow and shallow form of breathing and, most important, a marked and progressive fall in blood pressure.

The treatment of shock, consisting of control of hemorrhage, placing the patient prone with his head low, surrounding him with blankets, and administration of fluids, blood plasma, or whole blood (depending on the severity of the condition) is of the utmost importance.

It is not our purpose here to discuss the subject of shock but to stress the importance of immediate treatment for this condition if patients have sustained injuries of the facial bones.

ESTABLISHMENT OF AN AIRWAY

It is surprising how frequently the airway of a seriously injured, and particularly of a comatose, patient is disregarded or neglected. Injuries about the face and jaws, more than injuries in any other region, are likely to produce obstruction of the upper air passages. The tongue of an unconscious individual may fall back into the pharynx. In the presence of bilateral fractures of the anterior part of the mandible or of loss of the entire lower jaw, the patient may be unable to hold his tongue forward. Blood may accumulate in the hypopharynx until breathing is impossible. Compression injuries and deep lacerations in the anterior part of the neck may produce laryngeal edema sufficient to close off the airway. All such conditions should be sought for and remedied without delay. A suture or safety pin inserted in the tongue and taped to the chin will hold the tongue forward. Accumulation of blood in the pharynx can be prevented by turning the patient on his side with his head lowered. In some instances, an intratracheal tube may become necessary to maintain an airway, until tracheotomy can be performed.

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Infection of wounds in a soft tissue that overlies injured facial bones is a condition to be avoided if possible. Not only may the infection extend to the bony tissues themselves, but also it may necessitate long and undesirable delay in treatment of the injured bones. Probably no factors so favor the development of active infection in a wound as does improper cleansing, the presence of a hematoma or want of drainage. Hydrogen peroxide, in our experience, has been a most satisfactory cleansing agent for wounds because of its efficiency in removing debris and coagulated blood; it leaves the injured tissues clean and fresh for suturing. Since the formation of a hematoma is most undesirable, it is extremely important that a wound never be closed before the bleeding has been completely controlled by ligating every vessel from which blood continues to ooze. Furthermore, application of a pressure dressing to a wound immediately after suturing is to be recommended. Such a dressing should be left undisturbed for at least forty-eight hours, thereby obviating the possibility of formation of a hematoma. If already present, a hematoma should be removed promptly whether or not the injured part has been sutured. In reference to the drainage of wounds (figs. 1, 2 and 3), we prefer Penrose drains for use in large undermined wounds, but in those of smaller dimensions we use ordinary rubber bands; the latter make excellent drains and leave a minimal amount of scarring on removal. Very superficial lacerations, after being cleansed, can be closed safely without any form of drainage. Some surgeons are of the opinion that facial lacerations do not require drainage and believe that drains, when inserted, actually invite infection. On the contrary, we are confident that adequate drainage is extremely beneficial in extensively undermined facial wounds; drains allow for the escape of serum which may accumulate in the depths of a soft tissue pocket and which occasionally can serve as a culture medium for pathogenic bacteria.

In addition to the above measures for the prevention of infection in wounds of soft tissue, the local application of one of the sulfa drugs in the wound is indicated in grossly contaminated lacerations and particularly in war wounds. It is our opinion that the insertion of a large amount of one of the sulfa drugs in powdered form is inadvisable, as it tends to increase



Fig. 1.

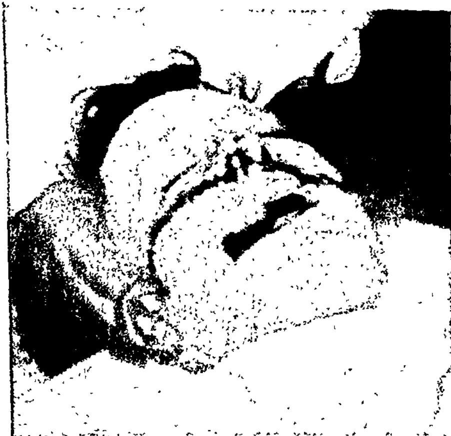


Fig. 2.



Fig. 3.

Fig. 1.—Severe laceration of the face associated with comminution of the right side of the mandible. The laceration extends through the right cheek, right ear, right middle ear and into the mastoid process.

Fig. 2.—Laceration represented in figure 1. The wound was cleansed with hydrogen peroxide, and a small amount of powdered sulfathiazole was applied locally before the wound was sutured. Several Penrose drains were used, as well as an iodoform pack in the right preauricular region. The wound involving the middle ear and mastoid process was left wide open. Soft tissue wounds were treated on the first day under local anesthesia. The fractures of the jaws were taken care of several days later.

Fig. 3.—Postoperative photograph of patient represented in figures 1 and 2. The residual deformity could be improved by plastic procedures.



a



b

Fig. 4



Fig. 5.

Fig. 4.—a and b. Facial lacerations associated with multiple fractures of all the facial bones and including the ethmoid bone. The injuries of soft tissues were treated on the day following the injury; care of the bony injuries was delayed for two weeks because of the ethmoid fracture.

Fig. 5.—Postoperative photograph of the patient represented in figure 4.

the subsequent formation of scar tissue. However, a very small amount of the preparation (we use sulfathiazole) does not affect materially the development of scar tissue and is definitely an aid in overcoming infection.

Regardless of the absence of gross contamination, every open wound undoubtedly is invaded by pyogenic organisms. Fortunately, with proper care, lacerations about the face of a healthy individual rarely are attended by clinical signs of infection. However, occasionally suppurating, traumatic facial wounds are not, or cannot, be given early treatment. In these instances, we adopt a most conservative regimen; the wounds are left entirely alone except for the continuous application of warm, moist dressings, until the acute inflammatory process has subsided.

The immediate plastic repair of defects such as loss of an extensive portion of the lip, cheek, nose or eyelid is impossible. In these cases, we prefer to disregard temporarily the resultant deformity; the wounds are left open, but this need not interfere with the treatment of associated injuries of facial bones. When the margins of the soft tissue defects are healed and when the subsequent inflammatory thickening and induration have entirely disappeared, construction of the lost part, by methods of plastic surgery, is undertaken.

INJURIES OF FACIAL BONES ASSOCIATED WITH A FRACTURED ETHMOID BONE

Many severe injuries of facial bones are associated with fracture of the cribriform plate of the ethmoid bone. Under such circumstances, cerebrospinal fluid usually drains from the nose for several days following the injury, and the danger in these cases is the possible development of meningitis. A fractured ethmoid bone is not uncommonly associated with severe crushing injuries to the nose and with certain types of fractures involving the maxilla. Consequently, every patient with a serious maxillary or nasal injury should be examined for possible cerebrospinal rhinorrhea, but not until treatment for shock has been instituted. It is sometimes difficult to distinguish mucus from cerebrospinal fluid draining from the nose. A somewhat crude but easy and effective method of making this determination consists in placing the patient on his side, allowing the secretions

simple fractures, treatment should be delayed until satisfactory roentgenograms of the bones of the face and dental roentgenograms can be obtained, and until the most desirable method of treatment can be determined. Complicated and serious fractures of facial bones require a great deal of preoperative planning, and often rather elaborate appliances for reduction and fixation. Under such circumstances, three or four days, or even longer, may be necessary to complete the plan of therapy.

Treatment of fractures of the jaw is successful only when the continuity of the bone has been established and when the normal masticatory mechanism has been restored. The fragments of a fractured jaw may be firmly healed by bony union, but the end result is failure if the original occlusion of the teeth has not been re-established to insure normal mastication. No single word has greater significance in any discussion of fractures of the jaws than does the term "occlusion." Nearly every fracture of a jaw in which there is the least displacement of the fragments causes some disturbance of occlusion, and unless the teeth can be brought into normal relationship, the fragments will not be restored to their original position. No factor serves as a better guide for determining the position of the fragments than does occlusion of the teeth. Frequently, in cases of fracture of the jaws, it is almost impossible to tell by visual inspection of the mouth what relationship actually existed between the upper and lower teeth before the fracture occurred; the difficulty may be the result of loss of many teeth in each dental arch or it may be due to primary malocclusion of the teeth. In these cases, preparation of plaster models of the dental arches will aid materially in determining the original form of occlusion. It can be said that fractures of the jaws cannot be satisfactorily reduced unless one is certain of the original position of the teeth in each case. A method of taking compound impressions of the teeth and preparing plaster models, which are cut at the site of the fractures and mounted on an articulator, is described on pages 553 to 555.

In general, then, reduction and immobilization of fractures of the jaws should be deferred, not only until roentgenograms of the jaws and dental roentgenograms can be secured but until plaster study models can be prepared. Only with such accessory

from the nose to drain on to a clean handkerchief. If the discharge is cerebrospinal fluid, it will soil the handkerchief but will not change the texture of the material, whereas the stained area produced by mucus will appear to be starched. The diagnosis of an associated ethmoid fracture is of the utmost importance in determining the subsequent form of treatment. It is our belief that patients with injuries of facial bones associated with a fractured ethmoid bone should be left entirely alone for ten to fourteen days following the injury. Associated wounds of soft tissue may be taken care of under local anesthesia soon after the accident (figs. 4 and 5), but manipulation of the bony structures of the face is most inadvisable. Attempts at reduction of fractures of facial bones during this period of two weeks may disturb the fracture of the ethmoid bone and invite infection of the adjacent meninges from the nasal cavity. When the diagnosis of an ethmoid fracture has been established, a neurosurgeon should be consulted. In some cases, spicules of bone may protrude into the overlying brain tissue and, under these circumstances, an open operation to remove such spicules is often indicated. Following the interval of ten to fourteen days, sufficient fibrous tissue has formed to wall off the defect of the ethmoid bone so that the necessary treatment of the facial bones may be undertaken with safety. One of the most valuable discoveries in recent years is the use of sulfa drugs in treatment of injuries of facial bones associated with fractures of the ethmoid bone. By the internal use of one of these drugs during the period of ten to fourteen days, many individuals with such ethmoid injuries can be saved from fatal meningitis. We cannot stress too strongly the importance of recognizing a fractured ethmoid bone associated with fractured facial bones, of deferring treatment of the facial bones under such circumstances for several days following the injury, and of the use of sulfa drugs as an aid in preventing meningitis.

GENERAL CARE OF FRACTURES OF FACIAL BONES

The hurried reduction and immobilization of fractured facial bones, with too little thought being given to the selection of methods most suitable to each individual case, often produce poor functional and cosmetic results. We believe that, even for



Fig. 6.—The distal root of the lower third molar root is exposed in the line of fracture. Consequently this root should be extracted to obviate the potential danger of necrosis of pulp and subsequent formation of an abscess. Part of the roentgenographic outline has been artificially accentuated.

diagnostic aids can one select the best method of treatment in each case.

Innumerable methods of reduction and immobilization have been described in the literature for the management of fractured jaws. Each has advantages and disadvantages; each is adaptable to certain types of fractures. No one method is suitable for every case. A few produce excellent results in the hands of some surgeons but not in the hands of others. Consequently, it is a mistake to attempt a comparison of the various methods. It is our opinion that those procedures with which the surgeon is acquainted, and which he finds satisfactory are the methods he should employ.

OSTEOMYELITIS AND NECROSIS OF BONE

Osteomyelitis is the most serious complication which may follow traumatic bony injuries, such as fractures, bullet wounds and shrapnel wounds. Not only may this complication result in necrosis, with loss of bone, nonunion of fractures, facial deformity, and interference with normal function of the jaws but also it occasionally may lead to septicemia and pyemia. Consequently, every conceivable measure should be taken to prevent infections of the bones about the face. To be specific, we wish to stress the following six measures, which aid in the prevention of osteomyelitis:

The Proper Care of Facial Wounds Involving Soft Tissue.—This subject has been discussed previously, on page 3.

Removal of Debris.—All debris and foreign substances should be removed if feasible. Loose pieces of bone which are completely detached from the periosteum, and which unquestionably would form sequestra, should be removed before one proceeds with the reduction and immobilization of fractures. Such foreign bodies and dead pieces of bone invite infection, delay healing of fractures and are potential causes of osteomyelitis.

Removal of Certain Teeth.—We wish to stress the importance of extracting every tooth, the root of which is exposed in a line of fracture (fig. 6). Due to interruption or strangulation of the blood supply, the pulp of such teeth is likely to become necrotic. This would initiate formation of an abscess that could, in turn, produce osteomyelitis. In our experience, re-



Fig. 8.—The crown and roots of the impacted third molar tooth are exposed in the line of fracture. Extraction of this tooth might displace the posterior fragment and consequently this tooth should not be disturbed. However, a through-and-through Penrose drain should be inserted close to this tooth and close to the line of fracture, thereby providing dependent drainage for any purulent material which might develop.

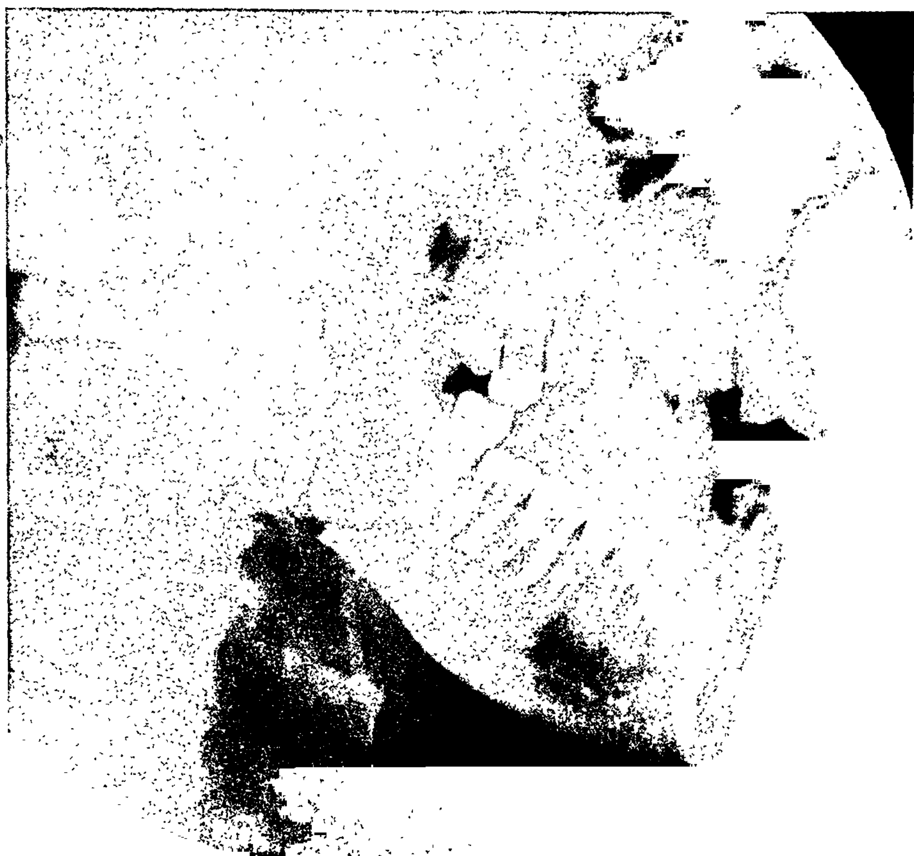


Fig. 7.—The mesial root of the lower third molar tooth is exposed in the line of fracture. Usually such a tooth should be extracted, but since the tooth is extremely valuable in this instance for fixation of the posterior fragment, it should be retained. However, if retained, a through-and-through Penrose drain should be inserted close to the tooth and close to the line of fracture, thereby providing free dependent drainage for any purulent material which might develop due to necrosis of the pulp of this third molar tooth. The lower second molar tooth, the distal root of which is exposed in the line of fracture, should be extracted.

teeth are retained to help in immobilization of the fragments.

Not infrequently, in the presence of fracture of the jaw, teeth are so badly damaged that death of the pulp is likely to ensue. Such teeth should be extracted promptly to avoid the development of an abscess.

Since extraction of teeth the roots of which are exposed in the line of fracture is of practical importance, the necessity of satisfactory dental roentgenograms as a preliminary measure is obvious. Examination of the teeth by means of dental roentgenograms is unquestionably a significant item in the preoperative plan of treatment for the patient with fracture of the jaw.

Adequate Drainage.—Under certain circumstances, wounds involving the facial bones require drainage. The use of a through-and-through Penrose drain (figs. 9 and 10) has been described (see "Removal of certain teeth") for fractures of the mandible in which teeth with exposed roots in the line of fracture are retained. In all cases of comminuted fracture of the lower jaw, we strongly recommend a similar type of drainage for a period of about ten days. Finally, any external wound exposing a large surface of one or more of the facial bones should not be sutured tightly without a drain.

Open Reduction for Fractures of the Jaw.—It is generally accepted that open operations for reduction or fixation of fractures of the jaws too often end in osteomyelitis, necrosis of bone, or nonunion (fig. 11). Consequently, if osteomyelitis is to be avoided we believe that open operations are never to be undertaken; one should rely on, and should have enough ingenuity to construct, intra-oral or external appliances which do not require surgical exposure of the line of fracture but which supply adequate immobilization of the fragments of the jaw.

Limited Use of Skeletal Traction (External Pin Fixation).—It is our opinion that the various external screw or pin appliances which have been devised to effect skeletal fixation and immobilization in cases of fracture of the jaws cannot be employed without some risk. Necrosis of bone about the pins or screws is always a possibility. However, the value of skeletal traction in treatment of some mandibular fractures should not be underestimated. To minimize the present value of pins or screws for fixation is not to deny the possibility of future prog-

moval of such teeth is one of the most important steps in prevention of infection and necrosis of bone. The only instances in which we do not extract teeth with roots exposed in the line of fracture are those in which the tooth is absolutely necessary for fixation of a bony fragment; for example, a single molar tooth in a short posterior fragment is better retained for fixation than extracted, even though its roots are exposed in the line of fracture (fig. 7). Occasionally, unerupted or impacted teeth are discovered in the line of fracture. Under such circumstances, we prefer not to remove these teeth for fear of further displacing the bony fragments (fig. 8).

When a lower tooth, the root portion of which is exposed in the line of fracture is retained, we strongly urge that a through-and-through Penrose drain be employed. Such a drain can easily be inserted in the following manner: A small, curved hemostat is introduced through the bucco-alveolar sulcus of the oral mucosa, adjacent to the line of fracture and on the external surface of the mandible. This instrument is forcibly pushed downward through the soft tissues along the site of the fracture until it reaches the subcutaneous tissues of the submaxillary triangle. A tiny incision then is made in the skin of this region, through which the tip of the hemostat emerges externally (fig. 9). By means of this instrument, a thin Penrose drain is carried through the tract occupied by the hemostat, from the submaxillary region externally, to the oral cavity within (fig. 10). The inner end of the drain is attached with a silk suture, to a tooth or to some intraoral appliance; the other end, which emerges in the submaxillary region, is cut off about ½ inch (about 1.5 cm.) below the cutaneous incision. A drain, so placed, usually is not removed for ten days following its insertion. Should an abscess occur from a tooth with roots exposed in the line of fracture, the Penrose drain supplies the necessary form of dependent drainage for any purulent material which may develop. This, in turn, prevents the spread of infection to adjacent bony and soft tissues. In our experience with fractured mandibles, an abscess or osteomyelitis is an extremely rare complication; we are confident that this rarity is due almost entirely to the fact that we extract all teeth the roots of which are exposed in the line of fracture, or insert through-and-through drains when such

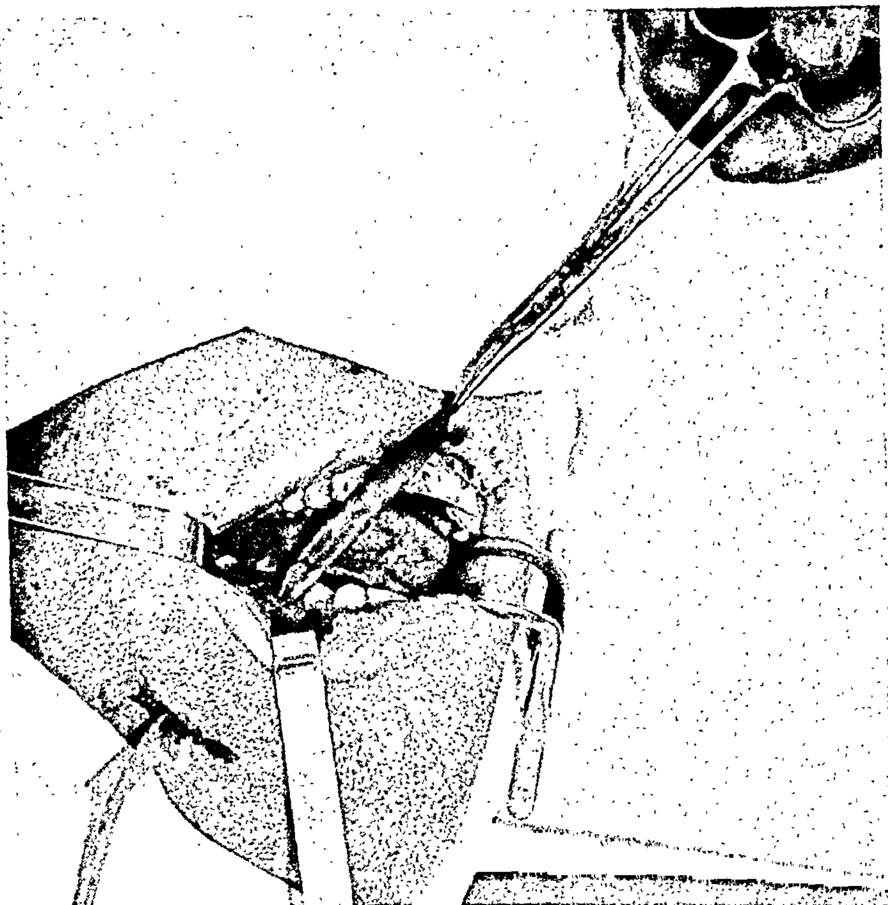


Fig. 10.—See figure 9. With the small forceps, the Penrose drain is drawn through the soft tissues adjacent to the line of fracture. This drain should be attached by a silk suture to a tooth or to an appliance within the oral cavity, and should be left in place for ten to fourteen days.

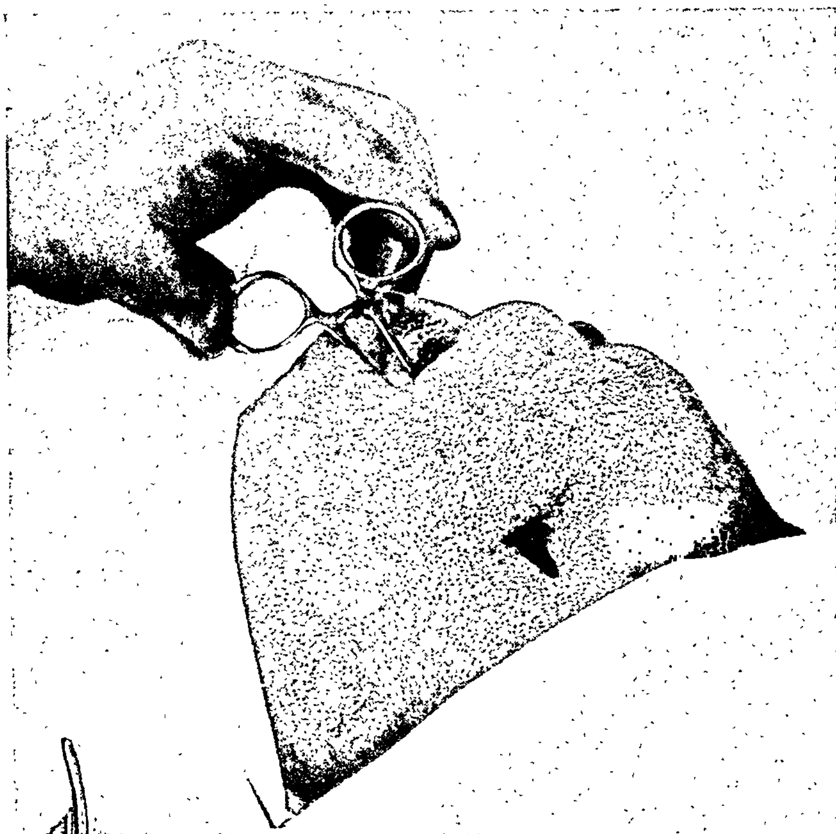


Fig. 9.—Preparation for insertion of a through-and-through Penrose drain, to be placed external to the alveolar process and close to the line of fracture. The purpose of such a drain is to provide dependent drainage for any purulent material which may develop from a retained tooth of which a root is exposed in the line of fracture, a potential cause of necrosis of the pulp. Such drains also should be placed adjacent to a badly comminuted, compound fracture, some small fragments of which may undergo sequestration and produce purulent discharge. A hemostat is thrust through the soft tissue that lies external to the line of fracture. The direction of the thrust is from the oral cavity, to and through a small incision in the submaxillary region. See figure 10.



Fig. 12.—It is preferable not to employ skeletal traction for fractures of the mandible when teeth are present. Under certain circumstances, however, this form of fixation may be used to advantage as a form of immobilization supplementary to that obtained by intermaxillary wiring. See text. As illustrated in this roentgenogram, devices for external pin fixation cannot be applied so as to insure normal dental occlusion. Notice the downward displacement of the posterior fragment. In a case of this type, no method of immobilization is as satisfactory as some form of intra-oral wiring. See figure 13.



Fig. 11.—This roentgenogram reveals nonunion necrosis of bone and sequestration, the result of open reduction and failure to extract the second molar tooth, the distal root of which is exposed in the line of fracture. When the patient came to the clinic, there was an externally draining sinus, through which was protruding the wire for fixation of the fragment. Drainage from this sinus persisted for three months, until the last bit of sequestrum was gone. The possibility of necrosis of bone and sequestration following open reduction of fractures of the jaw is very great. We disapprove of open reduction for any fractures of the mandible. See text page 13.

ress in this field of traumatic surgery. For a few fractures involving the lower jaw, these devices have changed the course of treatment from crude attempts at immobilization to simple and dependable technics of therapy. Yet, appliances for skeletal traction are not faultless instruments for immobilization of all fractures of the mandible; their use is always attended by the remote but actual possibility of producing necrosis of bone; this is particularly true should a pin be driven accidentally or inadvertently into the line of fracture, exposing the bone surrounding the pin to contamination by secretions from the oral cavity. Moreover, unless external pin fixation appliances are used in conjunction with intra-oral methods of fixation, they cannot be applied so as to insure normal dental occlusion (figs. 12 and 13). These appliances are certain to fall into disrepute if used indiscriminately, and particularly when applied improperly by inexperienced persons or when employed for immobilization merely to facilitate feeding.

It is our opinion that external pin fixation appliances should not be employed for fracture of the jaws if adequate immobilization can be gained by more conservative methods. For many fractures of edentulous lower jaws, direct skeletal fixation offers the ideal method of treatment; here the excellent fixation obtained by use of such appliances far outweighs their remote but potential dangers. However, when teeth are present, if natural dental occlusion is to be obtained, external pin fixation never should be employed to replace, but only to supplement, intraoral fixation.



Fig. 13.—See figure 12. External screw appliance, which had been in positio for one month, was removed. Bony union was absent, largely because the root of the first molar tooth were exposed in the line of fracture. Consequently, whe the patient came to the clinic, not only was the screw fixation appliance remove but also this first molar tooth was extracted. Hooked arch bars with inter maxillary elastic traction were employed to reduce and immobilize the fracture Notice how normal occlusion of the teeth has been re-established by this metho of treatment.

ess in this field of traumatic surgery. For a few fractures involving the lower jaw, these devices have changed the course of treatment from crude attempts at immobilization to simple and dependable technics of therapy. Yet, appliances for skeletal traction are not faultless instruments for immobilization of all fractures of the mandible; their use is always attended by the remote but actual possibility of producing necrosis of bone; this is particularly true should a pin be driven accidentally or inadvertently into the line of fracture, exposing the bone surrounding the pin to contamination by secretions from the oral cavity. Moreover, unless external pin fixation appliances are used in conjunction with intra-oral methods of fixation, they cannot be applied so as to insure normal dental occlusion (figs. 12 and 13). These appliances are certain to fall into disrepute if used indiscriminately, and particularly when applied improperly by inexperienced persons or when employed for immobilization merely to facilitate feeding.

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CHAPTER II

FRACTURES OF THE MANDIBLE

TRAUMATIC injuries may disturb the continuity of the mandible by producing single, double, bilateral, multiple or comminuted fractures or actual loss of bone. Of particular concern at present are the last two types of bony defects, so frequently the result of war injuries from bullets, shrapnel and other agents. Although the majority of fractures of the lower jaw are compound, a few are neither open to the oral cavity nor to the external skin surface. Many of the latter type, however, appear to be "closed" fractures, whereas in reality they are compound, due to tiny, inconspicuous or invisible tears in the overlying oral mucous membrane. Consequently, if complications are to be avoided, it is our opinion that all mandibular fractures, whether or not they are open and potentially infected, should be considered and treated as such. A great volume of desirable information appears in the literature on the etiologic factors, particularly the types, degrees, and directions of forces which contribute to the occurrence of various fractures of the lower jaw. But since these factors are of little, if any, practical value from a therapeutic point of view, we prefer not to discuss this phase of the subject here.

In any discussion in which the endeavor is to present a complete and detailed account of traumatic injuries of the jaws, some classification of the fractures and bony defects produced by such injuries is required if clarity of the presentation is to be obtained. Such a grouping for fractures of the upper jaw can be accomplished satisfactorily from the standpoint of therapy. However, in an attempt systematically to arrange fractures of the mandible, many obstacles are encountered. It is our opinion that a classification of fractures of the lower jaw is more comprehensive when based on their location than when based on their treatment. We believe that the following arrangement permits of -ffective discussion of mandibular fractures:

2

1. Single fractures of the mandible.
    a. Single fractures of the body of the mandible occurring somewhere in the region of the dental arch.
    b. Single fractures near, or involving, one angle of the mandible.
    c. Single fractures of the ramus, of the coronoid process or of the neck (subcondylar fracture).
2. Bilateral fractures of the mandible in various locations.
3. Double fractures involving one side of the mandible.
4. Multiple fractures of the mandible.
5. Badly comminuted fractures of the mandible.
6. Fractures of the lower alveolar process.
7. Fractures of a dentulous mandible associated with an edentulous maxilla.
8. Ununited fractures of the mandible.

In the following pages of this chapter, fractures of the mandible will be discussed according to the foregoing plan. The treatment outlined here is based on the assumption that there are no associated fractures of the maxilla. As will be pointed out in chapter VI, the routine management of fractures of the mandible often must be altered if, in addition, one or more fractures of the upper jaw are present.

In all cases of fracture of the mandible, the immediate care of the patient should be directed toward control of shock and hemorrhage. In cases of single fracture, shock is usually of little consequence and treatment of the fracture may be undertaken at any convenient time. Bilateral or double fractures of the mandible may produce some symptoms of shock, but multiple or severely comminuted fractures of the lower jaw are likely to induce a rather marked form of shock. Regardless of the type of fracture, treatment always should be deferred until all signs of shock have disappeared.

Problem 1 is taken up on page 25.



Fig. 14.—Text on page 25.

Single Fracture of Body of Mandible Anterior to Second Bicuspid Region; Teeth Present in Both Fragments and in Upper Jaw (Figs. 14 to 17 Inclusive)

COMMENTS

In cases of recent fracture of this type, reduction can be accomplished by manipulation. Single loop and intermaxillary wiring is one of the simplest, most rapid and most effective methods of immobilization, and is to be recommended unless there is some contraindication to wiring the patient's jaws together for a few weeks. Such contraindications are coma, nausea and vomiting. In coma the tongue may obstruct the airway; vomitus for which there is insufficient egress may be aspirated. Accordingly, it generally is not advisable to wire together the jaws of a patient who is to be aboard ship. Should any of these circumstances arise, then continuous loop wiring and intermaxillary elastic traction (fig. 16) are preferable. If fractures are impacted or if they are several days or weeks old (up to and including five weeks), reduction no longer can be accomplished by manipulation and we believe that hooked arch bars with strong intermaxillary elastic traction (fig. 17) are to be recommended. For the type of fractures under discussion, we dislike the use of skeletal traction pin appliances because they are unlikely to bring the teeth into good alinement, unless intermaxillary wiring is employed in conjunction. Moreover, for these simple fractures there is no need to risk the development of remote but possible complications which can arise from the use of pin appliances. Finally, we do not approve of the use of splints (silver or acrylic) for these fractures.

Treatment is considered on pages 27, 29 and 31.

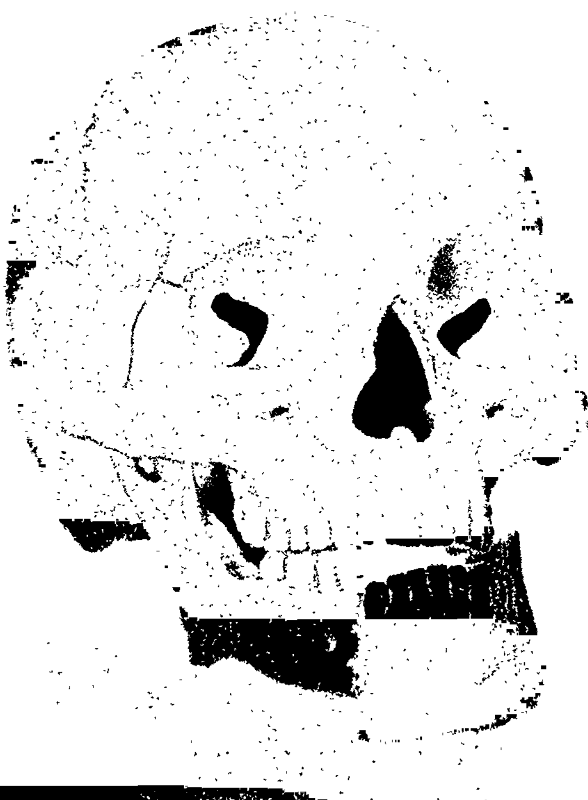


Fig. 14.—Text on page 25.

SINGLE FRACTURE OF BODY OF MANDIBLE ANTERIOR TO SECOND BICUSPID REGION; TEETH PRESENT IN BOTH FRAGMENTS AND IN UPPER JAW (FIGS. 14 TO 17 INCLUSIVE)

COMMENTS

In cases of recent fracture of this type, reduction can be accomplished by manipulation. Single loop and intermaxillary wiring is one of the simplest, most rapid and most effective methods of immobilization, and is to be recommended unless there is some contraindication to wiring the patient's jaws together for a few weeks. Such contraindications are coma, nausea and vomiting. In coma the tongue may obstruct the airway; vomitus for which there is insufficient egress may be aspirated. Accordingly, it generally is not advisable to wire together the jaws of a patient who is to be aboard ship. Should any of these circumstances arise, then continuous loop wiring and intermaxillary elastic traction (fig. 16) are preferable. If fractures are impacted or if they are several days or weeks old (up to and including five weeks), reduction no longer can be accomplished by manipulation and we believe that hooked arch bars with strong intermaxillary elastic traction (fig. 17) are to be recommended. For the type of fractures under discussion, we dislike the use of skeletal traction pin appliances because they are unlikely to bring the teeth into good alinement, unless intermaxillary wiring is employed in conjunction. Moreover, for these simple fractures there is no need to risk the development of remote but possible complications which can arise from the use of pin appliances. Finally, we do not approve of the use of splints (silver or acrylic) for these fractures.

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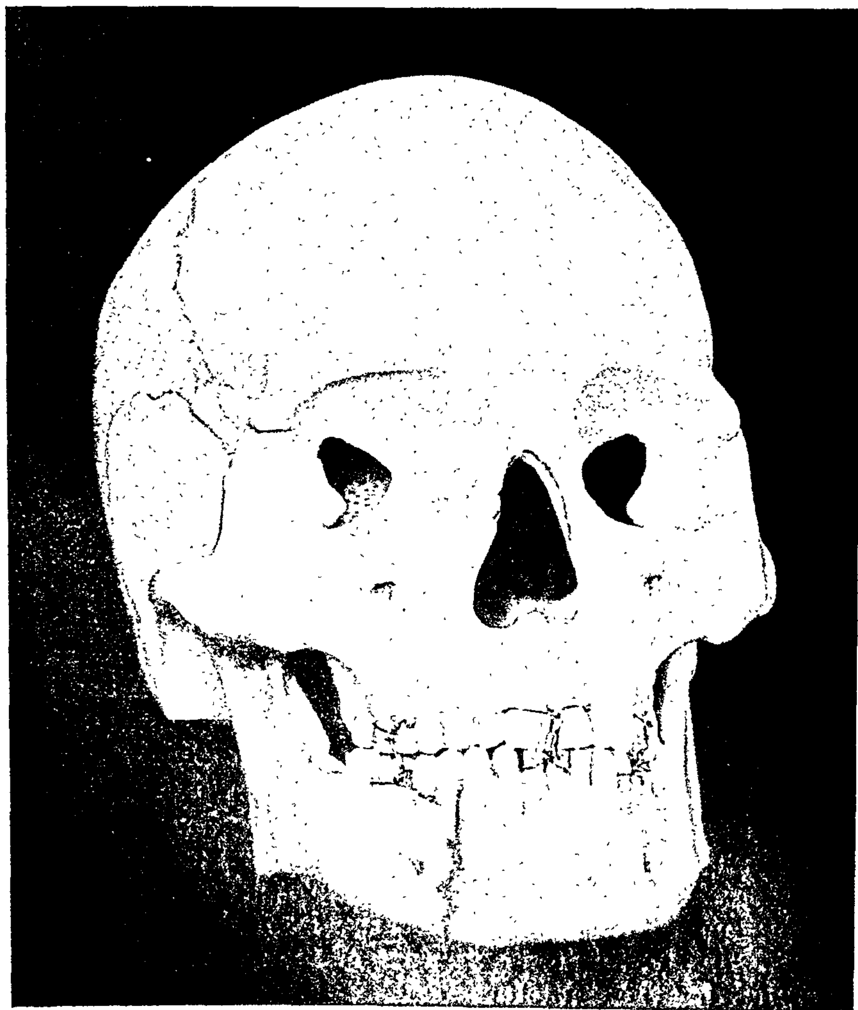


Fig. 15.—Text on page 27.

TREATMENT BY SINGLE LOOP AND INTERMAXILLARY WIRING (FIG. 15)

Extract any tooth the root portion of which is exposed in the line of fracture.

Apply single loop (eyelet) wires to the teeth of the upper and lower dental arches. In the short, posterior fragment one loop is sufficient but the long fragment requires at least two loops. See pages 521 to 523 for details of single loop wiring.

After forcing the teeth into occlusion, connect the upper and lower wire loops (eyelets) by double intermaxillary wires. Immobilization of the fracture is thereby completed.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube



Fig. 16.—Text on page 29.

TREATMENT BY CONTINUOUS LOOP AND INTERMAXILLARY ELASTIC TRACTION (FIG. 16)

Extract any tooth the root portion of which is exposed in the line of fracture.

Attach loop wires to the upper and lower teeth, constructing one series of loops in each lower fragment. These wires should not cross the line of fracture. See page 525 for details of continuous loop wiring.

After bending the loops to form hooks, stretch rubber bands with a moderate amount of tension between the loops on the upper and lower teeth. These rubber bands not only reduce the fracture but serve as a means of immobilization.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 17.—Text on page 31.

TREATMENT BY HOOKED ARCH BARS AND INTERMAXILLARY ELASTIC TRACTION (FIG. 17)

(Note: This method not only serves as a means of reducing fractures which are impacted or which are several days or weeks old, but also is extremely well adapted to the care of all recent fractures. While the proper attachment of arch bars to the teeth does require much time, this procedure insures perfect dental occlusion.)

Extract any tooth the root portion of which is exposed in the line of fracture.

Wire a hooked arch bar to the teeth in the upper dental arch, and similarly attach segments of hooked arch bars to the teeth in the lower fragments. See pages 526 to 528 for details.

Stretch rubber bands between the hooks of the upper and lower arch bars; such elastic traction gradually draws the teeth into proper occlusion and in turn reduces the fracture.

The intermaxillary elastic bands may be retained for immobilization of the fracture if the patient can be seen frequently during the period of healing of the fracture so that rubber bands can be replaced when broken. Otherwise these rubber bands should be replaced by double intermaxillary wires passed over the arch bars rather than over the hooks of these bars.

Maintain fixation of the fracture for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

Illustration on page 34.

Single Fracture of Body of Mandible in the Second Bicuspid, First Molar or Second Molar Region; Teeth Present in Both Fragments and in Upper Jaw (Fig. 18)

COMMENTS

When a fracture occurs in the second bicuspid, first molar or second molar region, then only one or two molar teeth may be present in the short posterior fragment. Under these circumstances, a somewhat difficult problem arises because a wire passed around but one or two molar teeth does not always maintain satisfactory fixation of the fragment. In our practice, we have solved this difficulty by attaching an orthodontia anchor clamp band having a buccal sheath (fig. 18) to one of the molar teeth in this short posterior fragment. Such a band requires no cement and, when properly seated, with its screw tightened, cannot become displaced. Moreover, its buccal sheath serves as an excellent attachment for rubber bands or for intermaxillary wires. If, by chance, an anchor clamp band is not available, the short posterior fragment must be immobilized as well as possible by the use of a wire passed around the molar tooth or teeth in this fragment and subsequently attached to the upper arch bar.

Treatment is considered on page 35.

Illustration on page 34.

TREATMENT BY MEANS OF A MOLAR BAND, HOOKED ARCH BARS, AND INTERMAXILLARY ELASTIC TRACTION (FIG. 18)

Extract any tooth the root portion of which is exposed in the line of fracture. However, if there is present but a single tooth in the posterior fragment, this tooth should be retained for fixation of the fragment even though its roots may be exposed. Under these circumstances, a through-and-through Penrose drain should be inserted close to the line of fracture as was described in chapter I, pages 12 to 15.

Attach an anchor clamp band having a buccal sheath to a molar tooth in the posterior fragment. See page 529 for details.

Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a segment of a hooked arch bar to the teeth in the lower anterior fragment. See pages 526 to 528.

Stretch rubber bands between the hooks of the upper and lower arch bars and between the upper arch bar and the sheath of the lower molar band; such elastic traction gradually draws the teeth into proper occlusion and in turn reduces the fracture.

The intermaxillary elastic bands may be retained for immobilization of the fracture, if the patient can be seen frequently during the period of healing of the fracture so that rubber bands can be replaced when broken. Otherwise, these rubber bands should be replaced by double intermaxillary wires passed over the arch bars rather than over the hooks of these bars.

Maintain fixation of the fracture for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 18.—Text on pages 33 and 35.

SINGLE FRACTURE OF BODY OF MANDIBLE; MOUTH PARTIALLY EDENTULOUS BUT WITH A FEW TEETH PRESENT IN EACH FRAGMENT AND IN UPPER JAW (FIG. 19)

COMMENTS

Not infrequently, a fracture of the body of the mandible occurs in a case in which the mouth is partially edentulous but a few teeth are still present in the lower fragments and in the upper jaw. The want of so many teeth produces some difficulty in immobilization of the fracture, because loop wires or hooked arch bars cannot be attached securely to the few teeth which are present. However, without resorting to the use of external pin fixation or to acrylic or silver splints, this problem can be nicely solved by employing orthodontia anchor clamp molar or bicuspid bands, round wire arch bars and intermaxillary wires (fig. 19). In fact, this arrangement is to be recommended as a safe and stable form of fixation, maintaining the teeth in perfect occlusion.

Treatment is considered on page 39.

Illustration on page 38.

TREATMENT BY ANCHOR CLAMP BANDS, ROUND WIRE ARCH BARS AND INTERMAXILLARY WIRES (FIG. 19)

Extract any tooth the root portion of which is exposed in the line of fracture. However, if but a single tooth is present in a fragment, this tooth should be retained for fixation of the fragment even though its roots may be exposed. Under these circumstances, insert a through-and-through Penrose drain close to the line of fracture, as was described in chapter I, page 12.

Apply anchor clamp bands to selected molar or bicuspid teeth, as is demonstrated in figure 19. For the upper jaw, adapt a round wire arch bar to the upper dental arch; insert this wire into the buccal sheaths of the upper molar or bicuspid bands; and finally, wire this bar to all the teeth intervening between the banded upper teeth. See page 531 for details.

In a similar manner, attach a segment of a round wire arch bar to the teeth and to the molar band in the long anterior fragment.

Attach an anchor clamp band having a buccal sheath to a molar tooth in the posterior fragment. See page 529 for details.

Manually reduce the fracture, and immobilize the fragments by means of double intermaxillary wires stretched between the molar bands or round wire arch bars. Should the fracture be several days or weeks old, rubber bands stretched between the upper and lower molar bands, or tied to the arch bars, will reduce the fracture by elastic traction.

Maintain fixation of the fracture for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

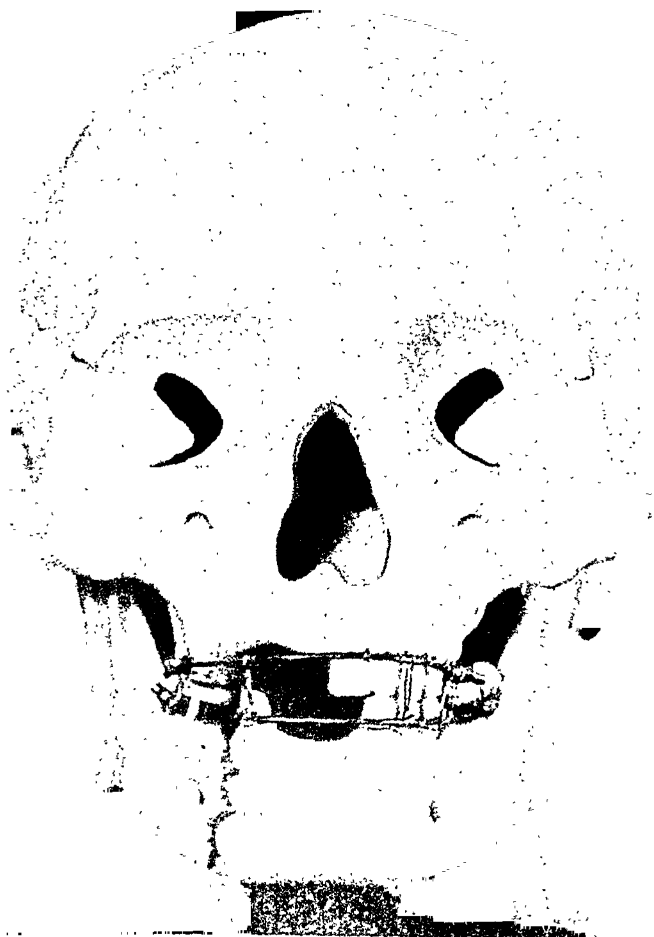


Fig. 19.—Text on pages 37 and 39.

TREATMENT BY ANCHOR CLAMP BANDS, ROUND WIRE ARCH BARS AND INTERMAXILLARY WIRES (FIG. 19)

Extract any tooth the root portion of which is exposed in the line of fracture. However, if but a single tooth is present in a fragment, this tooth should be retained for fixation of the fragment even though its roots may be exposed. Under these circumstances, insert a through-and-through Penrose drain close to the line of fracture, as was described in chapter I, page 12.

Apply anchor clamp bands to selected molar or bicuspid teeth, as is demonstrated in figure 19. For the upper jaw, adapt a round wire arch bar to the upper dental arch; insert this wire into the buccal sheaths of the upper molar or bicuspid bands; and finally, wire this bar to all the teeth intervening between the banded upper teeth. See page 531 for details.

In a similar manner, attach a segment of a round wire arch bar to the teeth and to the molar band in the long anterior fragment.

Attach an anchor clamp band having a buccal sheath to a molar tooth in the posterior fragment. See page 529 for details.

Manually reduce the fracture, and immobilize the fragments by means of double intermaxillary wires stretched between the molar bands or round wire arch bars. Should the fracture be several days or weeks old, rubber bands stretched between the upper and lower molar bands, or tied to the arch bars, will reduce the fracture by elastic traction.

Maintain fixation of the fracture for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

Illustrations on pages 42 and 44.

Single Fracture of Body of Edentulous Mandible (Figs. 20 and 21)

COMMENTS

If the line of fracture in an edentulous mandible is anterior to the second molar region, we are of the opinion that the most desirable plan of fixation is the use of an acrylic splint, which fits over the alveolar ridge and immobilizes the bony fragments by means of circumferential wires around the mandible (fig. 20). However, when the fracture involves the second or third molar region, then this procedure is of no value because a circumferential wire will not retain the short posterior fragment in proper relationship to the splint. Under these circumstances, we recommend external pin fixation (fig. 21). While there is a very remote possibility of some complication arising from the use of a pin appliance, in this situation its advantages far surpass its potential disadvantages.

Years ago, it was common practice to employ a Gunning splint (fig. 315) for fractures of the body of an edentulous mandible. This appliance requires an external bandage or some form of chin sling to hold the fragments of the lower jaw up against the splint. Inasmuch as this arrangement so frequently fails to immobilize the fragments satisfactorily, we no longer utilize a Gunning splint for this type of fracture.

Treatment is considered on pages 43 and 45.



Fig. 20.—Text on pages 41 and 43

TREATMENT BY ACRYLIC SPLINT AND CIRCUMFERENTIAL WIRES (FIG. 20)

The patient's lower denture, if available, may be employed as the splint. Otherwise an acrylic splint must be constructed in the following manner.

1. In dental compound secure impressions of the upper and lower dental arches.
2. Construct plaster casts from these impressions.
3. Saw through the lower plaster model at the site of the fracture.
4. On a dental articulator mount these plaster fragments in proper alinement to each other and to the upper plaster model.
5. On these models prepare a wax pattern of the splint (fig. 20).
6. Construct an acrylic splint from the wax pattern.

It is well to prepare transverse grooves over the occlusal surface of such a splint for the reception of each circumferential wire; these grooves help to retain the wires in proper position. Although if the posterior fragment is short only one circumferential wire can be used to advantage, when fragments are longer it is advisable to employ at least two such wires.

Apply circumferential wires around the mandible and over the splint, as described on page 533. Each circumferential wire should consist of a double strand of bronze or stainless steel wire. Brass or German silver wires cause irritation and, often, formation of abscess.

Maintain fixation for about four weeks.

Feed the patient a soft diet.



Fig. 21.—Text on page 45.

TREATMENT BY EXTERNAL DIRECT SKELETAL FIXATION (FIG. 21)

Into each bony segment, drive two pins which should be joined together by a connecting rod to form a two-pin unit in each fragment. These pins should not encroach on the line of fracture and should be placed close to the lower border of the mandible so as not to enter the mandibular canal. See pages 506 to 517 for details.

With the index finger of one hand within the mouth and with the other hand placed externally, reduce the fracture by manipulation. (Note: Should the fracture be several days or weeks old, it may be impossible manually to return the fragments to proper alinement. If such is the case, it often is preferable not to attempt further reduction of the fracture. However, if the fragments are markedly displaced, it becomes necessary to incise the scar tissue binding the ends of the fragments together before complete reduction is possible. This is easily accomplished through a small intra-oral, or an external, incision.)

Manipulate the two fragments into correct alinement. While holding them in proper position, fasten a fixation rod to the pin units in order to secure immobilization of the fragments.

Maintain fixation for about four weeks.

Feed the patient a soft diet.

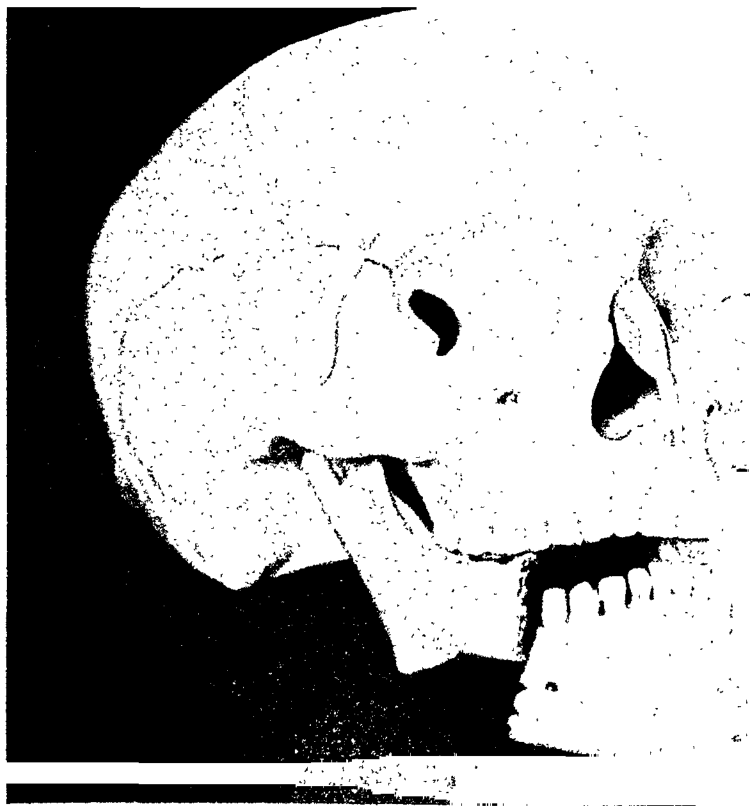


Fig. 22.—Text on page 47.

Single Fracture of Body of Mandible with No Teeth in a Long Posterior Fragment (Figs. 22 and 23)

COMMENTS

In a case of fracture of the body of the mandible in which there is a long, edentulous, posterior fragment (fig. 22) several methods of treatment have been advocated in the literature. One of the simplest, most effective and safest therapeutic measures to be recommended is the old method of using a bite block to maintain the posterior fragment in proper position while the teeth of the anterior fragment are wired in occlusion with the upper dental arch (fig. 23). Because this method offers satisfactory fixation for these fractures, we believe that one should not employ an extra-oral pin fixation appliance; the objections to this mechanism have been discussed in chapter I.

Treatment is considered on page 49.



Fig. 22.—Text on page 47.

TREATMENT BY USE OF A BITE BLOCK AND INTERMAXILLARY WIRING (FIG. 23)

If the root portion of a tooth in the anterior fragment is exposed in the line of fracture, this tooth should be extracted.

In dental compound obtain impressions of the upper and lower dental arches.

Prepare plaster models from these impressions in dental compound.

Cut the lower plaster model at the site of the fracture. Mount the lower plaster fragments and the upper plaster model on a dental articulator in such a manner that the teeth are in proper occlusion and that the lower plaster fragments approximate each other in normal alinement.

Prepare a wax model and subsequently an acrylic bite block with a saddle to fit over the alveolar ridge of the posterior fragment and with indentations for the opposing upper teeth. If so constructed, the block cannot become displaced when teeth of the anterior fragment are wired in occlusion.

Apply single loop (eyelet) wires to the teeth of the upper and lower dental arches. Three looped wires in each arch are sufficient.

Seat the bite block over the posterior fragment. When intermaxillary wires are attached to the loops on the upper and lower teeth, both lower fragments then are immobilized.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

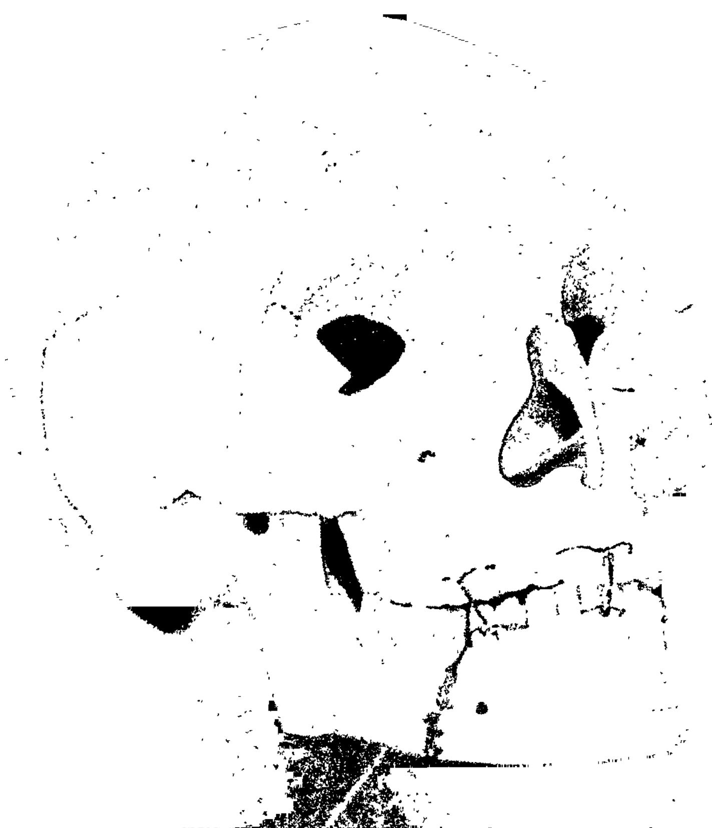


Fig. 23.—Text on page 49.

Single Fracture of the Body of the Mandible in Children; Teeth Present in Both Fragments and in Upper Jaw (Figs. 24 and 25)

COMMENTS

Fracture of the body of the mandible of an infant or young child was a serious problem in former years. Not only was it difficult to immobilize the fragments of the lower jaw but it was equally hard to feed these young children satisfactorily. Now, however, these problems need be relatively unimportant if one employs in the treatment a cast silver bite splint with circumferential wires. This type of fixation insures perfect immobilization of the fragments of the lower jaw and does not interfere with normal mastication of food. In fact, following application of such a splint, the child can carry on his ordinary activities throughout the period of healing of the fracture.

Details of treatment are discussed on page 53.

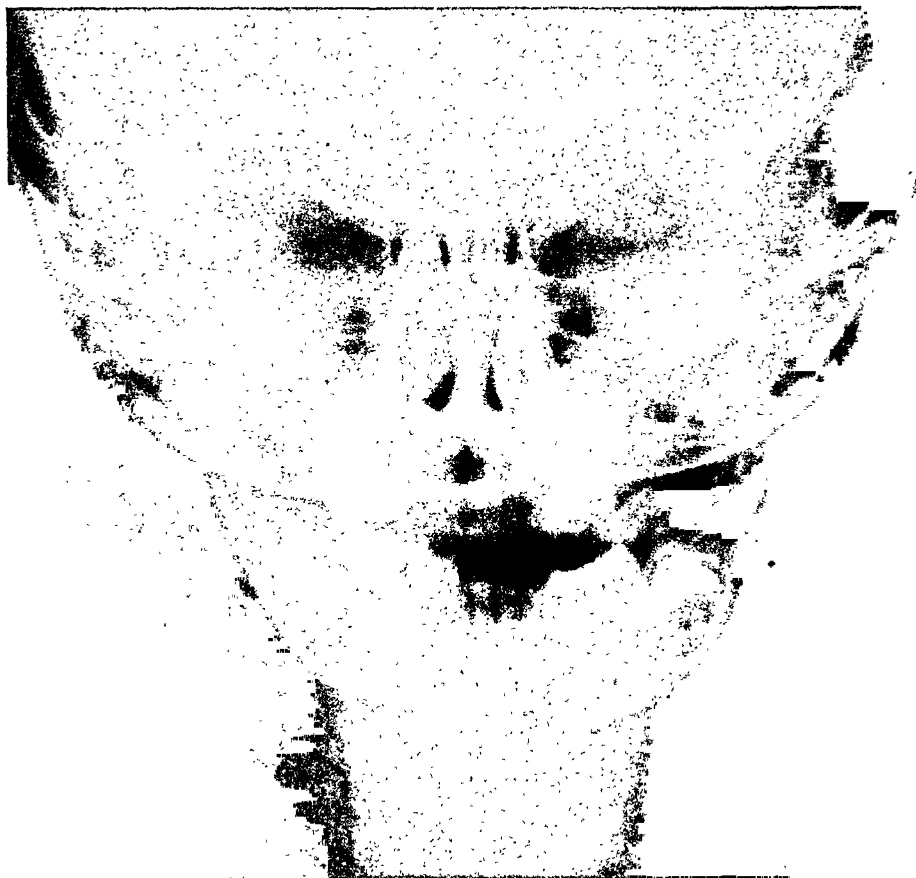


Fig. 21.—Roentgenogram of the jaws of a child, two and a half years of age, with a fracture of the right side of the mandible anteriorly. Long, anterior, left fragment displaced downward Text on page 51.

TREATMENT BY SILVER BITE SPLINT AND CIRCUMFERENTIAL WIRING (FIG. 25)

For fear of disturbing the conformation of the dental arches and the subsequent development of the jaws, it is preferable, in cases of children, not to extract teeth in the line of fracture unless these teeth are badly damaged. However, in retaining teeth the roots of which are exposed, it is well to insert a through-and-through Penrose drain, as has been discussed in chapter I, pages 12 to 15.

Obtain an impression in dental compound of the upper, and another of the lower, dental arches. If children are young and unco-operative, ether anesthesia may be required to obtain satisfactory impressions. From these dental compound impressions, prepare plaster models.

Cut the lower plaster model at the site of the fracture.

Mount the lower plaster fragments and the upper plaster model on a dental articulator. The teeth should be in proper occlusion.

Prepare a wax model and subsequently a silver occlusal bite splint. Such a splint should fit over only the occlusal third or half of the crowns of the lower teeth and should possess indentations for the opposing upper teeth. It is preferable to prepare loops on the buccal and lingual margins of such a splint, to which circumferential wires can be attached; this obviates the necessity of carrying the circumferential wires over the splint to interfere with the articulation of the splint with the upper teeth. Ordinarily, there should be two circumferential wires around the long, anterior fragment and one for the short, posterior fragment. If the child is very small, however, one circumferential wire around each fragment insures adequate fixation.

Under ether anesthesia, manually reduce the fracture and insert the cast silver splint over the lower teeth. Pass circumferential wires around the mandible, as is described on page 533, and attach these wires to the loops on the silver splint. These circumferential wires should consist of double strands of bronze or stainless steel wire, which do not cause abscesses to form in the soft tissues.

Maintain fixation four weeks. Feed a normal diet. The splint should not interfere with normal mastication.

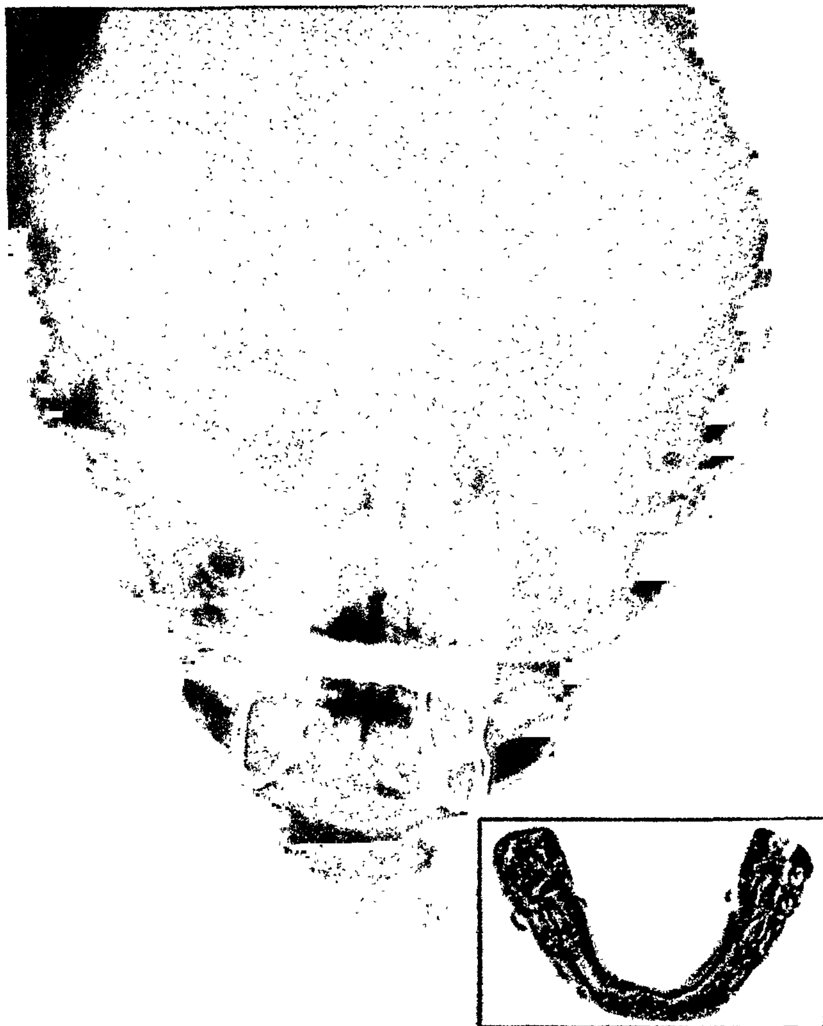


Fig. 25.—Text on page 53.

SINGLE FRACTURE NEAR ANGLE OF MANDIBLE; NO ANTERIOR DISPLACEMENT OF POSTERIOR FRAGMENT. TEETH PRESENT IN MANDIBLE AND IN MAXILLA (FIG. 26)

COMMENTS

The most important consideration in the presence of fracture near the angle of the mandible is the type and degree of displacement of the posterior fragment. Whether or not this fragment assumes, through muscular traction, an upward and forward position largely depends on the direction of the line of fracture. When the line of fracture passes more or less at right angles to the long axis of the mandible, there is mechanically little opportunity for the posterior fragment to be displaced forward. However, when the fracture assumes an oblique direction, backward and inward, then the posterior fragment in most instances is elevated and brought forward by muscular traction. If there is no forward displacement of the posterior fragment, as is the case in this problem 7, the method of fixation is very simple. Whether or not there is some lateral displacement of this fragment in relation to the anterior fragment is of little importance so long as the fractured surfaces of the two fragments are in contact.

Treatment is discussed on page 57.

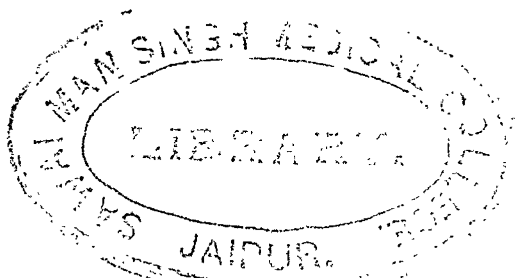


Illustration on page 56.

Single Fracture Near Angle of Mandible; No Anterior Displacement of Posterior Fragment. Teeth Present in Mandible and in Maxilla (Fig. 26)

COMMENTS

The most important consideration in the presence of fracture near the angle of the mandible is the type and degree of displacement of the posterior fragment. Whether or not this fragment assumes, through muscular traction, an upward and forward position largely depends on the direction of the line of fracture. When the line of fracture passes more or less at right angles to the long axis of the mandible, there is mechanically little opportunity for the posterior fragment to be displaced forward. However, when the fracture assumes an oblique direction, backward and inward, then the posterior fragment in most instances is elevated and brought forward by muscular traction. If there is no forward displacement of the posterior fragment, as is the case in this problem 7, the method of fixation is very simple. Whether or not there is some lateral displacement of this fragment in relation to the anterior fragment is of little importance so long as the fractured surfaces of the two fragments are in contact.

Treatment is discussed on page 57.



Fig. 26.—Text on pages 55 and 57.

TREATMENT BY SINGLE LOOP AND INTERMAXILLARY WIRING (FIG. 26)

If the root of the tooth in the anterior fragment next to the line of fracture is exposed, extraction of this tooth is to be recommended providing that it can be accomplished without too much difficulty. However, if there is any possibility of displacing the posterior fragment by such an extraction, we would prefer to retain this tooth and insert a through-and-through Penrose drain close to the line of fracture, as is described in chapter I, pages 12 to 15.

Apply single loop (eyelet) wires to the teeth of the upper and lower dental arches. Three looped wires in each arch are sufficient. See page 523 for details.

After forcing the teeth into occlusion, connect the upper and lower wire loops (eyelets) by double intermaxillary wires. Immobilization of the fragments is thereby completed.

If the anterior fragment cannot be manipulated so that the lower teeth occlude properly with the upper dental arch, simple loop and intermaxillary wiring should not be employed. Instead, hooked arch bars and intermaxillary elastic traction are indicated.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

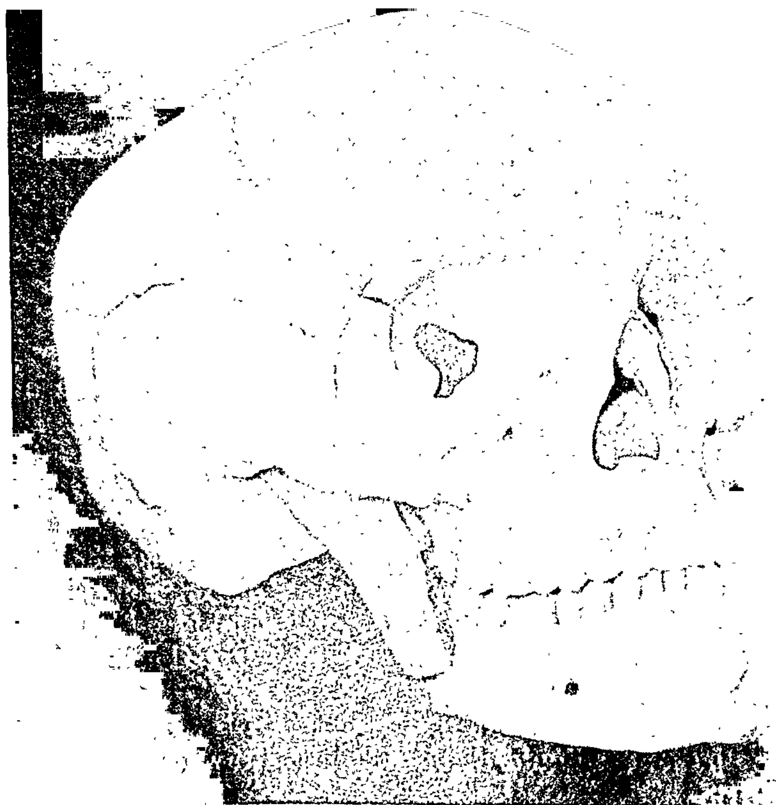


Fig. 27 — Text on page 59

Single Fracture Near Angle of Mandible; Anterior Displacement of Posterior Fragment; Teeth Present in Mandible and in Maxilla (Figs. 27, 28 and 29)

COMMENTS

As was discussed in problem 7, the important consideration in cases of fracture near the angle of the mandible is the position of the posterior fragment, that is; whether or not this fragment is drawn upward and forward by muscular traction. When this fragment is displaced anteriorly (fig. 27), two methods of treatment are available.

The first method consists in the insertion of a wire through the posterior fragment, after surgically exposing the angle of the mandible. This wire is connected, by means of a rubber band, to a hook which emerges in the mastoid region from a plaster head cast (fig. 28). Such an arrangement tends to retract and immobilize the posterior fragment while fixation of the anterior fragment is accomplished by intermaxillary wiring. Although the elastic traction between the wire in the posterior fragment and the hook of the head cast will draw the posterior fragment back into its normal position, this mechanical arrangement will not necessarily control any tendency toward lateral displacement of this fragment. Consequently, we believe that it is advisable in cases such as this to employ the second method of treatment, that of external skeletal fixation.

While we are somewhat reluctant to employ appliances for extra-oral pin or screw fixation, these devices do offer the most satisfactory method of immobilizing fractures near the angle of the mandible. In fact, for fractures in this particular location, the excellent fixation obtained by the use of such appliances far outweighs their remotely potential dangers. Together with direct skeletal fixation, intermaxillary wiring should be employed to insure normal occlusion of the teeth in the anterior fragment with the upper dental arch. When using this combined arrangement, it is unnecessary to use two pins in each fragment since one assures adequate fixation. If one prefers a screw fixation appliance, it could be employed to advantage here (fig. 29).

Occasionally, a patient with a fracture of the mandible near the angle is not, or cannot be, treated for several days following

the injury. Sufficient fibrous tissue may have developed around the fractured surfaces to prohibit manipulation of the fragments into their proper position. In cases such as this, it often is advisable to insert a wire into the posterior fragment; then, by elastic traction to a plaster head cast, this fragment can be pulled gradually back into proper alinement. This technic, of course, necessitates preliminary fixation of the anterior fragment by intermaxillary wiring. Following this type of reduction, there may or may not be a tendency toward lateral displacement of the posterior fragment. If such is the case, external skeletal fixation is indicated to insure immobilization of the posterior fragment in proper relationship to the remaining portion of the mandible.

Details of treatment are discussed on pages 63 to 65.

Problem 8 continued on the next page.



Fig. 28.—Text on pages 63 and 64.

TREATMENT BY FIXATION OF THE POSTERIOR FRAGMENT TO A PLASTER HEAD CAST AND IMMOBILIZATION OF THE ANTERIOR FRAGMENT BY INTERMAXILLARY WIRING (FIG. 28)

(Note: This type of fixation can be employed for any fracture near the angle of the mandible in which there are teeth in the anterior fragment and in which the posterior fragment is displaced forward. However, it is to be recommended particularly for older fractures in this region which require elastic traction for reduction.)

If the root of the tooth in the anterior fragment next to the line of fracture is exposed this tooth should be extracted.

Surgically expose the angle of the mandible. Drill a hole through the fragment of which the angle is a part and, close to the angle, insert a double strand of 26 gauge bronze or stainless steel wire. See pages 540 to 549 for details.

Apply a plaster head cast in which has been incorporated a hook that emerges in the mastoid region. This hook can be made of coat-hanger wire. For details of construction of a plaster head cast, see pages 479 to 495.

Apply single loop (eyelet) wires to the teeth of the upper and lower dental arches. Three looped wires in each arch are sufficient. See page 523 for details.

After forcing the teeth into occlusion, connect the upper and lower wire loops (eyelets) by double intermaxillary wires. Immobilization of the anterior fragment is thereby completed.

If the anterior fragment cannot be manipulated so that the lower teeth occlude properly with the upper dental arch, simple loop and intermaxillary wires should not be employed. Instead, hooked arch bars and intermaxillary elastic traction are indicated. Such elastic traction gradually draws the teeth into occlusion, after which the rubber bands should be replaced by double intermaxillary wires passed over the arch bars.

Following immobilization of the anterior fragment by intermaxillary wiring, a strong rubber band is stretched from the wire in the posterior fragment to the hook of the head cast. After the posterior fragment has been forced back into proper position, this rubber band should be replaced by a double wire to maintain fixation of the posterior fragment (fig. 28).

If the posterior fragment tends to become displaced laterally in spite of this method of fixation, use of an external pin ap-



Fig. 29.—Text on page 65.

pliance is to be recommended to maintain proper fixation of this fragment (fig. 29).

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

TREATMENT BY EXTERNAL PIN FIXATION APPLIANCE AND INTERMAXILLARY WIRING (FIG. 29)

If the root of the tooth in the anterior fragment next to the line of fracture is exposed, this tooth should be extracted.

Into each bony fragment drive a single pin or screw (fig. 29). In treating the type of fractured mandible under discussion, the skeletal fixation appliance furnishes immobilization merely supplementary to that obtained by the intermaxillary wires. Consequently, two pins in each fragment are unnecessary to secure thorough fixation.

Apply single loop (eyelet) wires to the teeth of the upper and lower dental arches. Three looped wires in each arch are sufficient. See page 523 for details.

After forcing the teeth into occlusion, connect the upper and lower wire loops (eyelets) by double intermaxillary wires. Immobilization of the anterior fragment is thereby completed.

If the anterior fragment cannot be manipulated so that the lower teeth occlude properly with the upper dental arch, simple loop and intermaxillary wires should not be employed. Instead, hooked arch bars and intermaxillary elastic traction are indicated. Such elastic traction gradually draws the teeth into occlusion, after which the rubber bands should be replaced by double intermaxillary wires passed over the arch bars.

Following immobilization of the anterior fragment by intermaxillary wires, the posterior fragment is manipulated into proper alinement and is immobilized by attaching the connecting bar to the pins or screws. While the pin or screw appliance immobilizes the posterior fragment, the intermaxillary wires fix the anterior fragment and maintain teeth in normal occlusion. If manual reduction of the fracture is impossible, it is necessary to employ intermaxillary elastic traction together with elastic traction extending from a wire in the posterior fragment to a plaster head cast; this was described on page 63.

Maintain fixation for about four weeks. The pin or screw appliance can be removed in three weeks if desirable.

Feed the patient a liquid diet through a straw or glass tube.

Illustration on page 68.

Single Fracture Near the Angle of an Edentulous Mandible; Upper Jaw Also Edentulous. Posterior Fragment Displaced Forward (Fig. 30)

COMMENTS

In an edentulous mouth, a fracture near the angle of the mandible offers a difficult problem in immobilization. The use of a skeletal traction appliance is to be recommended here since it offers a more perfect form of fixation than can be obtained by any other method.

Treatment is considered on page 69.

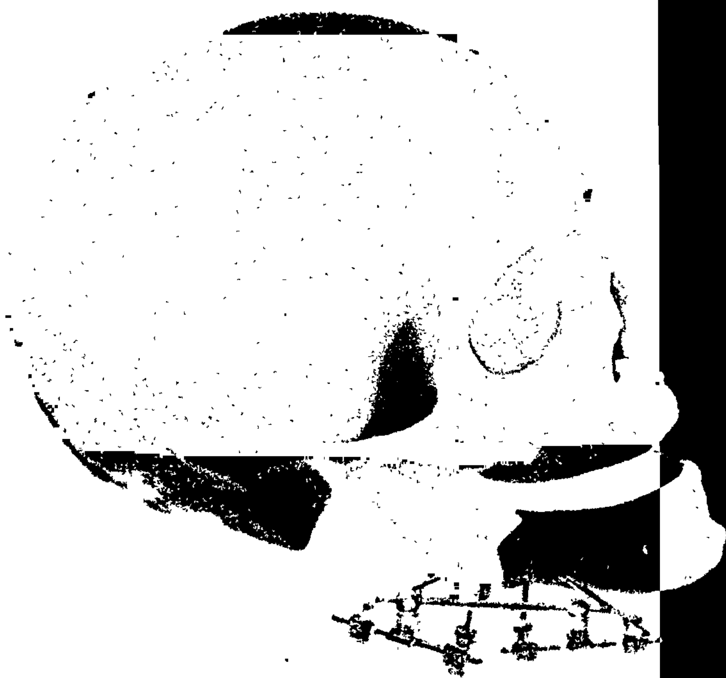


Fig. 30.—Text on pages 67 and 69.

TREATMENT BY EXTERNAL SKELETAL FIXATION (FIG. 30)

In employing skeletal traction for a fracture of an edentulous mandible, two pins are required in each fragment.

Into each bony segment, drive two pins which should be joined together by a connecting rod to form a two-pin unit in each fragment. These pins should not encroach on the line of fracture and should be placed close to the lower border of the mandible so as not to enter the mandibular canal (fig. 30).

Manipulate the two fragments into correct alinement. While holding them in proper position, fasten a fixation rod to the pin units in order to secure immobilization of the fragments. See pages 506 to 517.

Maintain fixation for about four weeks.

Feed the patient a soft diet.

Illustration on page 72.

Single Fracture of Ramus or of Coronoid Process (Fig. 31)

COMMENTS

A fracture of the ramus or of the coronoid process produces little or no displacement of the body of the mandible but, when teeth are present, a short period of immobilization is to be recommended. However, if the mandible is edentulous, fixation usually is unnecessary.

Treatment is considered on page 73.



Fig. 31.—Text on pages 71 and 73.

TREATMENT BY SINGLE LOOP AND INTERMAXILLARY WIRING (FIG. 31)

If the mandible is edentulous, no fixation is required.

If teeth are present:

Apply single loop (eyelet) wires to the teeth of the upper and lower dental arches. Three looped wires in each arch are sufficient. See page 523 for details.

After forcing the teeth into occlusion, connect the upper and lower wire loops (eyelets) by double intermaxillary wires. Immobilization is thereby completed. (Note: If desired, continuous loop wiring or hooked arch bars and elastic traction could be employed rather than the single loop and intermaxillary wires.)

Maintain fixation for two or three weeks.

Feed the patient a liquid diet through a straw or glass tube.

Illustration on page 76.

Subcondylar Fracture of Mandible (Figs. 32, 33 and 34)

COMMENTS

Regardless of displacement of the condyle, a subcondylar fracture requires no treatment other than immobilization of the mandible for a period of three weeks. Usually, at the site of fracture, a false joint develops which does not interfere with function of the jaws. Many surgeons, however, recommend open operation for this type of fracture; the aim of such a surgical procedure is to remove or replace the displaced condyle. It is our opinion that these operative technics not only invite certain potential complications, particularly fibrous ankylosis, but also that they fail to improve the ultimate functional result. A great many subcondylar fractures have been treated conservatively at the clinic, and we never have seen one in which there was any gross disturbance in function of the mandible, even though the condyle was markedly displaced.

For subcondylar fractures, it is advisable not to maintain immobilization of the jaws for more than three weeks. Even after this length of time some difficulty in opening the mouth results. Such rigidity is of no consequence and entirely disappears with subsequent use of the jaws. However, a longer period of immobilization tends to increase the amount of stiffness which the patient experiences on removal of the dental wires.

Occasionally, in a case of subcondylar fracture, the condyle is driven into the mandibular fossa or through the tympanic plate of the temporal bone. With the latter injury, bleeding from the external auditory canal is likely to occur. Even though the bone of the mandibular fossa or of the tympanic plate may be comminuted as the result of a subcondylar fracture, there still is no indication for open operation. However, it is true that fibrous ankylosis is much more likely to occur subsequent to these injuries than subsequent to simple subcondylar fracture.

Treatment is considered on pages 77, 79 and 81.

Illustration on page 76.

TREATMENT OF SUBCONDYLAR FRACTURE BY INTERMAXILLARY WIRING; TEETH PRESENT IN MANDIBLE AND MAXILLA (FIG. 32)

Immediate Care of Patient.—A subcondylar fracture produces little or no shock. However, when associated with a comminuted fracture of the glenoid fossa or of the tympanic plate, noticeable shock may develop and should receive prompt treatment. If the tympanic plate of the temporal bone is fractured, hemorrhage from the external auditory canal is likely to occur. This condition should be distinguished from basal fracture of the skull.

Management of the Fracture.—Apply single loop (eyelet) wires to the teeth of the upper and lower dental arches. Three looped wires in each arch are sufficient. See page 523 for details.

After forcing the teeth into occlusion, connect the upper and lower wire loops (eyelets) by double intermaxillary wires. Immobilization is thereby completed.

If the anterior fragment cannot be manipulated so that the lower teeth occlude properly with the upper dental arch, simple loop and intermaxillary wires should not be employed. Instead, hooked arch bars and intermaxillary elastic traction are indicated. Such elastic traction gradually draws the teeth into occlusion. These rubber bands may be retained for immobilization of the mandible or may be replaced by double intermaxillary wires.

Maintain fixation for three weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 32.—Text on pages 75 and 77.

TREATMENT OF SUBCONDYLAR FRACTURES WHEN THE CONDYLE IS ROTATED MARKEDLY OUTWARD (FIG. 33)

(Note: In some cases of subcondylar fracture, the condyle is rotated laterally to such a degree that the fractured edge can be palpated in the preauricular region. Under these circumstances, it is advisable to force the condyle inward if possible. The technic of this procedure is described below.)

Apply single loop (eyelet) wires to the teeth of the upper and lower dental arches. Three looped wires in each arch are sufficient.

Insert a mouth gag on the involved side. When this instrument is widely opened, the mandible is forced downward.

With a sharp pointed instrument thrust through the skin in the preauricular region, carefully force the short posterior fragment inward. While retaining this fragment in proper position, remove the mouth gag and force the mandible upward until the lower teeth are in occlusion with the upper dental arch. Frequently, by this procedure, the fractured surfaces can be engaged in fairly normal apposition.

Before releasing the manual support on the mandible, apply double intermaxillary wires between the wire loops on the upper and lower teeth.

Maintain fixation for three weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 33.—Text on page 79

TREATMENT OF SUBCONDYLAR FRACTURES WHEN THE CONDYLE IS ROTATED MARKEDLY OUTWARD (FIG. 33)

(Note: In some cases of subcondylar fracture, the condyle is rotated laterally to such a degree that the fractured edge can be palpated in the preauricular region. Under these circumstances, it is advisable to force the condyle inward if possible. The technic of this procedure is described below.)

Apply single loop (eyelet) wires to the teeth of the upper and lower dental arches. Three looped wires in each arch are sufficient.

Insert a mouth gag on the involved side. When this instrument is widely opened, the mandible is forced downward.

With a sharp pointed instrument thrust through the skin in the preauricular region, carefully force the short posterior fragment inward. While retaining this fragment in proper position, remove the mouth gag and force the mandible upward until the lower teeth are in occlusion with the upper dental arch. Frequently, by this procedure, the fractured surfaces can be engaged in fairly normal apposition.

Before releasing the manual support on the mandible, apply double intermaxillary wires between the wire loops on the upper and lower teeth.

Maintain fixation for three weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 34.—Text on page 81.

TREATMENT OF SUBCONDYLAR FRACTURE OF AN EDENTULOUS MANDIBLE (FIG. 34)

If there is little or no apparent displacement of the mandible, treatment is not indicated. However, should the mandible be definitely displaced, immobilization in its proper position for two or three weeks is indicated. To secure such immobilization, wire the patient's dentures together to form a Gunning splint. (To facilitate feeding of the patient, it is well to remove two or three anterior teeth from one or both plates).

If the patient's dentures are not available, a Gunning splint can be constructed in the following manner:

1. In dental compound obtain impressions of both jaws.
2. Prepare plaster models from these dental impressions.
3. Mount the two plaster models in normal relationship on a dental articulator.
4. Prepare a wax model for a Gunning splint. See figure 315*a*.
5. Prepare an acrylic splint from the wax model.

After insertion of the Gunning splint in the mouth, employ some form of head bandage or chin sling to hold the lower jaw up in proper relationship with the splint. (Note: This arrangement does not effect perfect immobilization but does aid in maintaining the lower jaw in fairly normal position.)

Maintain fixation for two or three weeks.

Feed the patient a liquid diet through a straw or glass tube.

Illustrations on pages 84 and 88.

Bilateral Fracture of Anterior Portion of Body of Mandible; Teeth in Three Lower Fragments and in Upper Jaw (Figs. 35 and 36)

COMMENTS

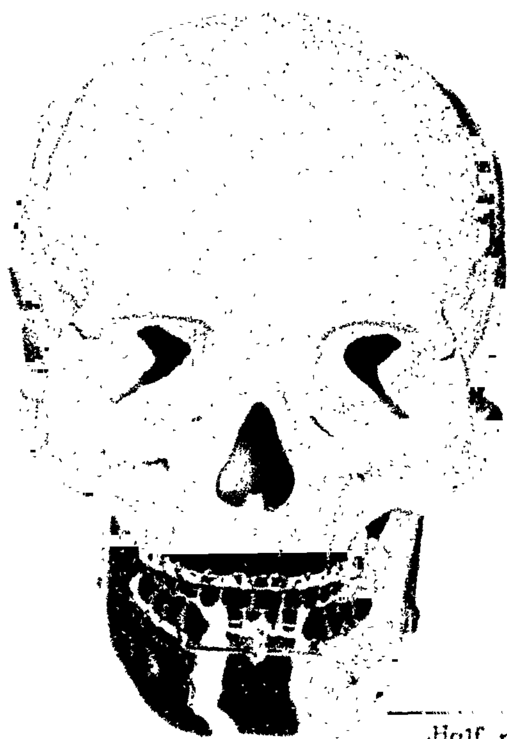
In cases of bilateral fracture of the anterior portion of the mandible, the blow that produces the injury is usually directed toward the symphysis and causes inward (fig. 35) or downward (fig. 36) displacement of the middle fragment. Frequently, the two lateral fragments are pulled together in front of, or above, the middle fragment. In many instances, the fragments can be manipulated into fairly normal position and, by subsequent application of elastic traction to hooked arch bars, the teeth can be brought into their original occlusion and the fragments immobilized in correct alinement. Occasionally, it is impossible manually to force the middle fragment into its correct relationship to the two lateral fragments. Under these circumstances, some form of appliance is needed to force the two lateral fragments apart, thereby providing sufficient space for replacement of the middle fragment.

The use of external pin fixation is of no value in treatment of the fractures that are being considered in this problem. Skeletal traction does not aid in reduction of the fractures and the dental wires which are required to bring the teeth into proper occlusion can be employed for immobilization as well.

In edentulous jaws with a bilateral fracture in the anterior part of the mandible, the treatment is identical with that described in Problem 15.

A mandible with bilateral anterior fractures, in which the middle fragment is without teeth, can most satisfactorily be treated by the same method as that shown in figure 55, which see. This treatment requires forcible manipulation of the fragments into position and the use of a cast silver splint with circumferential wires.

Treatment is considered on pages 85, 86 and 89.



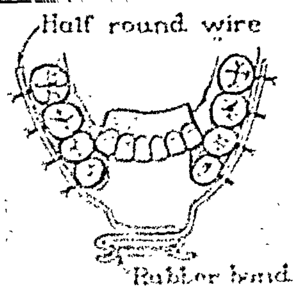


Fig. 25.—Text on pages 83, 85 and 86

TREATMENT WHEN THE MIDDLE FRAGMENT IS DISPLACED BACKWARD (FIG. 35)

Extract any tooth the root portion of which is exposed in the line of fracture. Should there be but four incisor teeth in the middle fragment, it is advisable not to remove any of these teeth even though one or more may present exposed roots. On the contrary, it is preferable to retain these teeth for fixation of the fragment, but through-and-through Penrose drains should be used as was described in chapter I, pages 12 to 15.

If the three lower fragments can be manipulated into fairly good position, the treatment is as follows:

1. Wire a hooked arch bar to the teeth of the upper dental arch.

2. Wire segments of hooked arch bars to the teeth of the three lower fragments. The arch bars never should cross the lines of fracture.

3. Manipulate the three fragments approximately into their normal positions. By means of rubber bands stretched between the hooks of the upper and lower arch bars, force the teeth into proper occlusion and, in turn, reduce the fractures. The intermaxillary elastic bands can be retained for immobilization of the fracture if the patient can be seen frequently during the period of healing of the fracture, so that rubber bands can be replaced when broken. Otherwise, these rubber bands should be replaced by double intermaxillary wires passed over the arch bars rather than over the hooks of these bars.

If the two lower fragments override the middle fragment and if they cannot be manipulated into proper position, the following treatment is indicated:

1. Some form of appliance is needed to separate the two lateral fragments so that space is provided for the middle fragment. We recommend employing an orthodontia jackscrew for this purpose. To each lower lateral fragment is wired a segment of a round wire arch bar. This bar, after being annealed, should be doubled. This prevents its rotation when it is wired to the teeth in the fragment. The anterior, inner end of each of these arch bars is bent forward and mesially for reception and retention of the orthodontia jackscrew (fig. 35).

2. A hooked arch bar is wired to the teeth of the upper dental arch and a small segment of a hooked arch bar is wired to the teeth in the middle fragment. (Note: The wires around the four teeth in the middle fragment may not offer sufficient retention for the small segment of arch bar. Under these circumstances, a circumferential wire passed around the middle fragment and brought over the bar between the two lower central incisor teeth will completely stabilize the arch bar, regardless of the amount of traction applied to it (fig. 36).

3. A jackscrew is inserted between the round wire arch bars of the two lower lateral fragments. By means of this appliance, the two lateral fragments are separated. See page 505.

4. A rubber band, when stretched from the jackscrew to the arch bar of the middle fragment, brings this fragment forward into position.

5. Intermaxillary rubber bands are applied between the upper arch bar and the arch bars of the lower fragments. Subsequently, the jackscrew is removed; the bent mesial ends of the arch bars which are attached to the lateral fragments, and which retained the jackscrew, are clipped off with a wire cutter to prevent irritation of the mucosa of the lower lip. The intermaxillary elastic bands force the teeth into occlusion and completely reduce the fractures. These rubber bands may be retained for immobilization of the fragments or can be replaced with double intermaxillary wires.

(Note: We prefer this method of separating the lower fragments over the old method of using elastic traction, which is demonstrated in the insert of figure 35, because the jackscrew not only separates the fragments but serves as a point of attachment for the rubber band, which brings the middle fragment forward. If a jackscrew is not available and the fragments cannot be manipulated into position, one must resort to the older method of separating the lateral fragments.)

Regardless of what method is employed to reduce the fractures, immobiliz[illegible] should be maintained for four weeks.

Feed the [illegible] [illegible]id diet through a straw or glass tube.

Problem 12 is continued on the next page.

2. A hooked arch bar is wired to the teeth of the upper dental arch and a small segment of a hooked arch bar is wired to the teeth in the middle fragment. (Note: The wires around the four teeth in the middle fragment may not offer sufficient retention for the small segment of arch bar. Under these circumstances, a circumferential wire passed around the middle fragment and brought over the bar between the two lower central incisor teeth will completely stabilize the arch bar, regardless of the amount of traction applied to it (fig. 36).

3. A jackscrew is inserted between the round wire arch bars of the two lower lateral fragments. By means of this appliance, the two lateral fragments are separated. See page 505.

4. A rubber band, when stretched from the jackscrew to the arch bar of the middle fragment, brings this fragment forward into position.

5. Intermaxillary rubber bands are applied between the upper arch bar and the arch bars of the lower fragments. Subsequently, the jackscrew is removed; the bent mesial ends of the arch bars which are attached to the lateral fragments, and which retained the jackscrew, are clipped off with a wire cutter to prevent irritation of the mucosa of the lower lip. The intermaxillary elastic bands force the teeth into occlusion and completely reduce the fractures. These rubber bands may be retained for immobilization of the fragments or can be replaced with double intermaxillary wires.

(Note: We prefer this method of separating the lower fragments over the old method of using elastic traction, which is demonstrated in the insert of figure 35, because the jackscrew not only separates the fragments but serves as a point of attachment for the rubber band, which brings the middle fragment forward. If a jackscrew is not available and the fragments cannot be manipulated into position, one must resort to the older method of separating the lateral fragments.)

Regardless of what method is employed to reduce the fractures, immobilization should be maintained for four weeks.

Feed the patient a liquid diet through a straw or glass tube.

TREATMENT WHEN THE MIDDLE FRAGMENT IS DISPLACED DOWNWARD (FIG. 36)

Extract any tooth the root portion of which is exposed in the line of fracture. Should there be but four incisor teeth in the middle fragment, it is advisable not to remove any of these teeth even though one or more may present exposed roots. On the contrary, it is preferable to retain these teeth for fixation of the fragment, but through-and-through Penrose drains should be used, as was described in chapter I, pages 12 to 15.

If the two lateral fragments do not require mechanical separation, treatment is as follows:

1. Wire a hooked arch bar to the teeth of the upper dental arch, and wire segments of hooked arch bars to the teeth in the three lower fragments. (The arch bars never should cross the lines of fracture.)

2. Stretch rubber bands between the hooks of the upper and lower arch bars to reduce the fractures and bring the teeth into occlusion.

3. The intermaxillary elastic bands may be retained for immobilization of the fracture if the patient can be seen frequently during the period of healing of the fracture so that rubber bands can be replaced when broken. Otherwise, these rubber bands should be replaced by double intermaxillary wires passed over the arch bars, rather than over the hooks of these bars.

If the two lateral fragments require mechanical separation, this can be accomplished as was described on pages 85 and 86.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 86.—Text on pages 85 and 89.

Bilateral Fractures of Body of Mandible in Molar Region
(Figs. 37, 38 and 39)

COMMENTS

Bilateral fractures of the body of the mandible in the molar region are not of uncommon occurrence; their treatment is dependent entirely on the teeth which are present or absent in the three lower fragments, as is discussed on pages 93, 95 and 97. External pin fixation is to be recommended for these fractures only when absolutely necessary to gain immobilization of an edentulous fragment.

Treatment is considered on pages 93 to 97.

Illustrations on pages 92, 94 and 96.

TREATMENT WHEN TEETH ARE PRESENT IN ALL THREE LOWER FRAGMENTS AND IN UPPER JAW (FIG. 37)

Extract any tooth the root portion of which is exposed in the line of fracture. However, if there is present but a single tooth in either posterior fragment, this tooth should be retained for fixation of the fragment even though its roots may be exposed. Under these circumstances, a through-and-through Penrose drain should be inserted close to the line of fracture, as was described in chapter I, pages 12 to 15.

Attach an anchor clamp band, having a buccal sheath, to a molar tooth in each lower posterior fragment. See page 529 for details.

Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a hooked arch bar to the teeth in the lower middle fragment. See pages 526 to 528 for details.

Stretch rubber bands between the hooks of the upper arch bars and between the upper arch bar and the sheaths of the two molar bands below; such elastic traction gradually draws the teeth into proper occlusion and in turn reduces the fracture. The intermaxillary elastic bands may be retained for immobilization of the fractures if the patient can be seen frequently during the period of healing of the fractures, so that rubber bands can be replaced when broken. Otherwise these rubber bands should be replaced by double intermaxillary wires passed over the arch bars rather than over the hooks of these bars.

Maintain fixation of the fractures for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 37.—Text on page 93.

TREATMENT WHEN TEETH ARE LOST FROM THE TWO POSTERIOR FRAGMENTS (FIG. 38)

Extract any tooth in the anterior fragment the root portion of which is exposed in the line of fracture.

To secure immobilization of the fragments in bilateral fractures of this type, the use of external pin fixation devices is unnecessary because adequate fixation can be obtained by means of intra-oral appliances. We prefer to employ a cast silver splint which is cemented to the teeth of the anterior middle fragment; the flange, or saddle, portions of this splint fit over the alveolar ridge of the two posterior fragments and are secured to the latter by circumferential wires. Such a splint is constructed in the following manner:

1. In dental compound secure impressions of the upper and lower dental arches.
2. From these impressions prepare plaster models.
3. Saw through the lower plaster model at the sites of the fractures.
4. Mount the lower plaster fragments and the upper plaster model in proper relationship on a dental articulator.
5. Prepare a wax model of the splint on the mounted plaster models. That portion of the splint which surrounds the teeth of the anterior middle fragment should be constructed with labial hooks or loops for the attachment of intermaxillary rubber bands (fig. 38).
6. Cast a silver splint from the wax pattern.

Cement the silver splint to the teeth of the lower anterior fragment, after manipulating all three lower fragments into correct alinement. In some instances, it is well to pass one or two circumferential wires around the lower anterior fragment and over the silver splint to insure perfect fixation of the splint to this bony fragment.

Pass one circumferential wire around each posterior fragment and over the saddles of the splint to immobilize the posterior fragments. For details see page 533.

Wire a hooked arch bar to the teeth in the upper dental arch. See pages 526 to 528 for details.

Stretch rubber bands between the hooks of the upper arch bar and the hooks or loops of the silver splint; such elastic trac-



Fig. 38.—Text on pages 95 and 96.

TREATMENT WHEN TEETH ARE ABSENT FROM THE ANTERIOR MIDDLE FRAGMENT (FIG. 39)

Extract any tooth the root portion of which is exposed in the line of fracture. However, when there is present but a single tooth in either posterior fragment, this tooth should be retained for fixation of the fragment even though its roots may be exposed. Under these circumstances, a through-and-through Penrose drain should be inserted close to the line of fracture, as was described in chapter I, pages 12 to 15.

To secure immobilization of the fragments under the circumstances being discussed here, there is no method of fixation so satisfactory as that obtained by direct skeletal fixation in addition to intermaxillary wiring. Although the intermaxillary wiring is not represented in figure 39, this combined method of treatment is outlined textually as follows:

Attach an anchor clamp band having a buccal sheath to a molar tooth in each posterior fragment. See page 529 for details.

Wire a hooked arch bar to the teeth in the upper dental arch. See pages 526 to 528 for details.

Into each bony segment, drive two pins which should be joined together by a connecting rod to form a two-pin unit in each fragment. These pins should not encroach on the line of fracture and should be placed close to the lower border of the mandible so as not to enter the mandibular canal.

Apply double intermaxillary wires between the upper arch bar and the two lower molar bands. This arrangement fixes the two posterior fragments in proper relation to the upper jaw.

Manipulate the lower anterior fragment into correct alinement and attach a fixation rod on either side to the pin units in order to secure immobilization of the lower anterior fragment.

If desirable, the intermaxillary wires can be removed at this stage, permitting the patient to open his mouth.

Maintain fixation for about four weeks.

Feed the patient a soft diet.

tion gradually draws the splint and lower fragments into proper relationship to the upper dental arch. The intermaxillary rub-

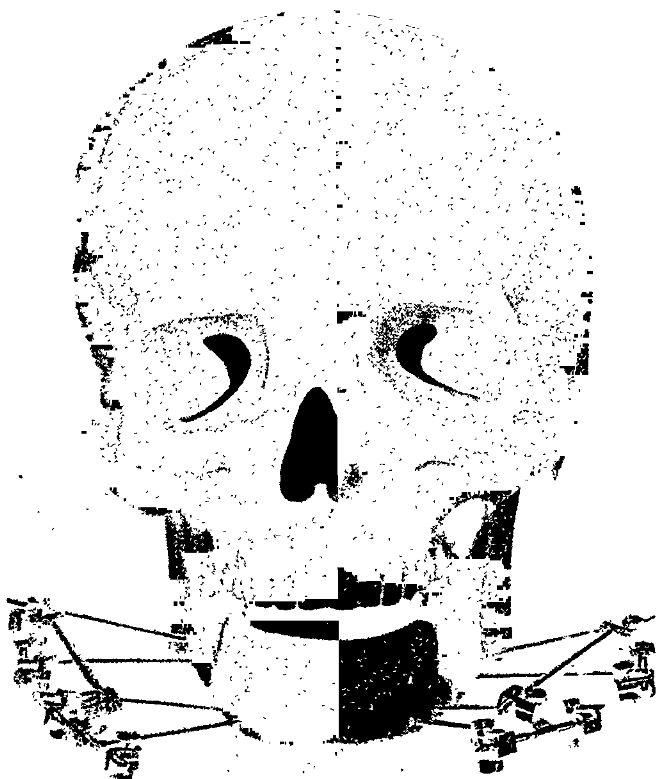


Fig. 39.—Text on page 97.

ber bands may be retained for immobilization or may be replaced by double intermaxillary wires.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

TREATMENT WHEN TEETH ARE ABSENT FROM THE ANTERIOR MIDDLE FRAGMENT (FIG. 39)

Extract any tooth the root portion of which is exposed in the line of fracture. However, when there is present but a single tooth in either posterior fragment, this tooth should be retained for fixation of the fragment even though its roots may be exposed. Under these circumstances, a through-and-through Penrose drain should be inserted close to the line of fracture, as was described in chapter I, pages 12 to 15.

To secure immobilization of the fragments under the circumstances being discussed here, there is no method of fixation so satisfactory as that obtained by direct skeletal fixation in addition to intermaxillary wiring. Although the intermaxillary wiring is not represented in figure 39, this combined method of treatment is outlined textually as follows:

Attach an anchor clamp band having a buccal sheath to a molar tooth in each posterior fragment. See page 529 for details.

Wire a hooked arch bar to the teeth in the upper dental arch. See pages 526 to 528 for details.

Into each bony segment, drive two pins which should be joined together by a connecting rod to form a two-pin unit in each fragment. These pins should not encroach on the line of fracture and should be placed close to the lower border of the mandible so as not to enter the mandibular canal.

Apply double intermaxillary wires between the upper arch bar and the two lower molar bands. This arrangement fixes the two posterior fragments in proper relation to the upper jaw.

Manipulate the lower anterior fragment into correct alinement and attach a fixation rod on either side to the pin units in order to secure immobilization of the lower anterior fragment.

If desirable, the intermaxillary wires can be removed at this stage, permitting the patient to open his mouth.

Maintain fixation for about four weeks.

Feed the patient a soft diet.

Illustrations on pages 100 and 102.

BILATERAL FRACTURE OF THE MANDIBLE; ONE FRACTURE INVOLVING THE BODY, THE OTHER PASSING THROUGH THE ANGLE OR NECK ON THE OPPOSITE SIDE. TEETH PRESENT IN MANDIBLE AND MAXILLA (FIGS. 40 AND 41)

COMMENTS

Not infrequently a fracture of the body of the mandible, particularly in the first molar or bicuspid region, is associated with a fracture near the angle or through the neck of the opposite side.

The treatment which we have found most satisfactory for such fractures is described on pages 101 and 103.

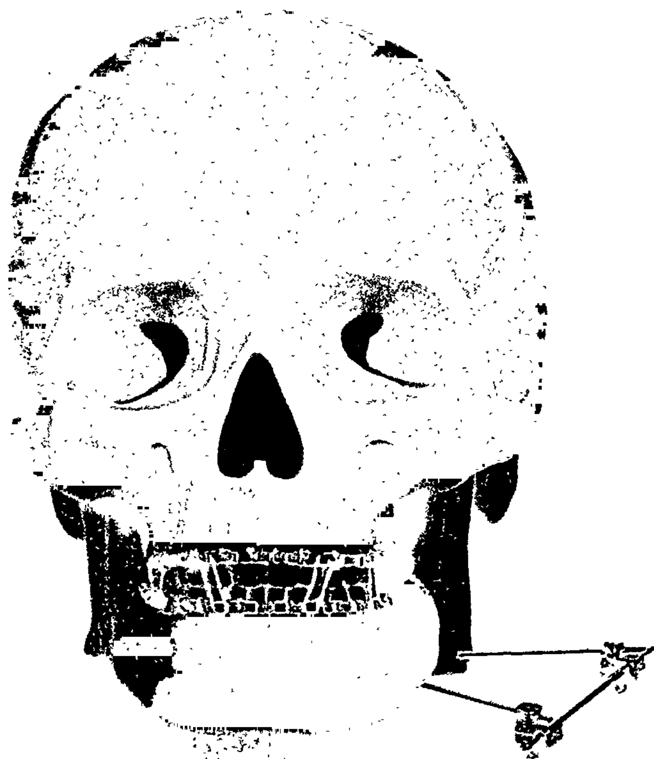


Fig. 40.—Text on page 101.

TREATMENT WHEN THE FRACTURES INVOLVE THE MOLAR REGION ON ONE SIDE AND THE ANGLE OF THE OPPOSITE SIDE (FIG. 40)

Extract any tooth the root portion of which is exposed in the line of fracture. However, if there is present but a single molar tooth in the long posterior fragment this tooth should be retained for fixation of the fragment even though its roots may be exposed. Under these circumstances, a through-and-through Penrose drain should be inserted close to the line of fracture.

If the short posterior fragment is anteriorly displaced, immobilization of this fragment can be obtained through a wire attached to a plaster head cast. However, a more satisfactory result could be obtained by external skeletal fixation.

Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a hooked arch bar to the teeth of the lower anterior fragment. See pages 526 to 528 for details.

Attach an anchor clamp band with a buccal sheath to a molar tooth in the longer posterior fragment. See page 529 for details.

Drive a single pin into the shorter posterior fragment and one into the anterior middle fragment. In treating this fracture at the angle, the skeletal fixation appliance furnishes merely supplementary immobilization to that obtained by intermaxillary wires. Two pins in each of these fragments are unnecessary to secure thorough fixation. These pins should not encroach on the line of fracture and should be close to the lower border of the mandible, so as not to enter the mandibular canal.

Stretch rubber bands between the hooks of the upper and lower arch bars and between the upper arch bar and the sheath of the lower molar band; such elastic traction gradually draws the teeth into proper occlusion.

Following reduction of the fracture involving the body of the mandible, the intermaxillary elastic bands should be replaced by double intermaxillary wires. These intermaxillary wires effect immobilization of the anterior middle fragment and the long posterior segment.

Manipulate the short posterior fragment into its natural position and immobilize by means of a fixation rod which is fastened to the two pins. Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

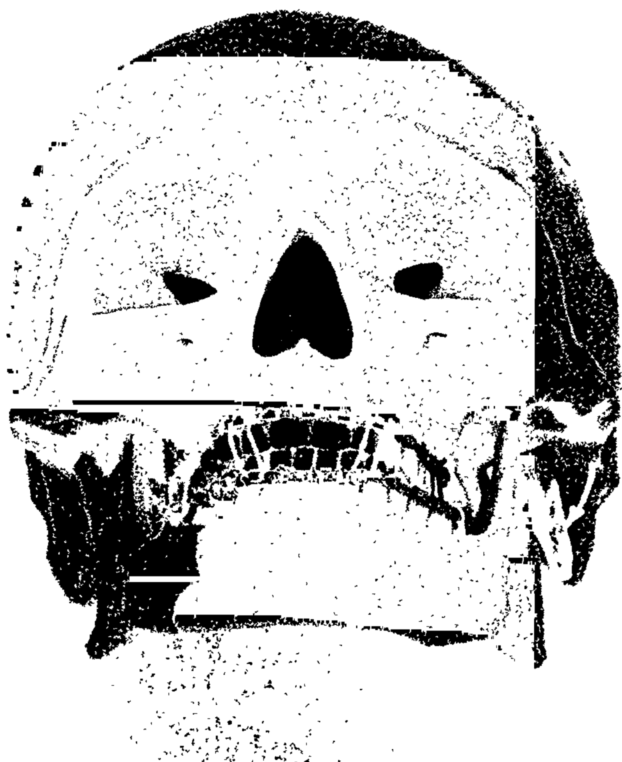


Fig. 41.—Text on page 103.

TREATMENT WHEN THE FRACTURES INVOLVE THE MOLAR REGION OF ONE SIDE AND THE SUBCONDYLAR REGION OF THE OPPOSITE SIDE (FIG. 41)

Extract any tooth the root portion of which is exposed in the line of fracture. However, if there is present but a single molar tooth in the long posterior fragment, this tooth should be retained for fixation of the fragment even though its roots may be exposed. Under these circumstances, a through-and-through Penrose drain should be inserted close to the line of fracture, as was described in chapter I, pages 12 to 15.

In a bilateral fracture of this type, immobilization can be secured merely by intermaxillary wires. The subcondylar fracture requires no treatment.

Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a hooked arch bar to the teeth of the lower middle fragment. See pages 526 to 528 for details.

Attach an anchor clamp band with a buccal sheath to a molar tooth in the long posterior fragment. See page 529 for details.

Stretch rubber bands between the hooks of the upper and lower arch bars and between the upper arch bar and the sheath of the lower molar band; such elastic traction gradually draws the teeth into occlusion.

The intermaxillary elastic bands may be retained for immobilization of the fracture if the patient can be seen frequently during the period of healing of the fracture, so that rubber bands can be replaced when broken. Otherwise, these rubber bands should be replaced by double intermaxillary wires passed over the arch bars rather than over the hooks of these bars.

(Note: If the long posterior fragment is edentulous, a cast silver splint should be employed, with circumferential wires to immobilize this posterior fragment, as was described in Problem 13, figure 38. If this fragment is too short to fit under the saddle portion of such a splint, then an external pin fixation appliance should be employed instead.)

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 42.—Text on page 105.

BILATERAL FRACTURE OF THE BODY, OR AT THE ANGLES, OF AN EDENTULOUS MANDIBLE (FIGS. 42, 43 AND 44)

COMMENTS

In cases of bilateral fracture of the body or angles of an edentulous mandible there is often a tendency of the three fragments to be telescoped together. In cases of recent fracture it is not difficult to return the fragments to normal alinement but, when such fractures are many days old, manipulation is difficult or impossible. Under the latter circumstances, elastic traction is required for reduction of the fractures. In figure 44, which see, the elastic bands have been replaced by wires.

There is always a desire to consider open reduction for fractures of this type, but we believe there is much less risk in employing external pin fixation appliances for immobilization of the fragments. If manipulation is impossible, elastic traction, extending from wires inserted into the bony fragments to a plaster head cast, usually will accomplish the desired reduction of the fractures.

Treatment is considered on pages 107, 109 and 110.

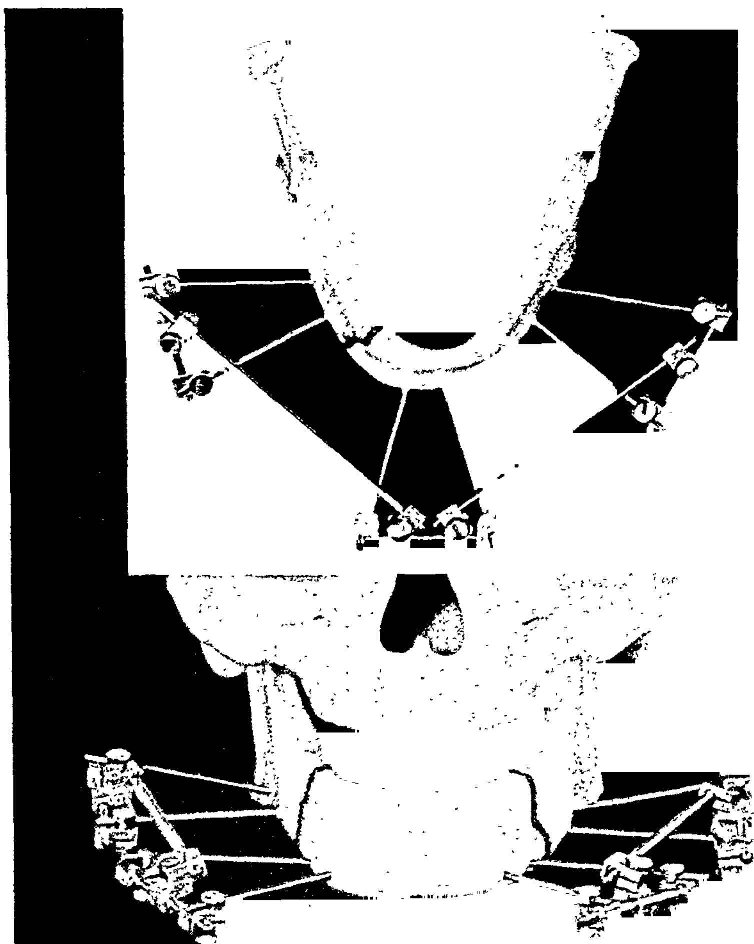


Fig. 43.—Text on page 107.

TREATMENT BY EXTERNAL PIN FIXATION APPLIANCES (FIG. 43)

Into each posterior bony segment drive two pins which should be joined together by a connecting rod to form a two-pin unit in each fragment. Insert a two-pin unit in the anterior fragment on each side. If the fractures are situated anteriorly, so that the anterior fragment is relatively short, one two-pin unit is sufficient for the anterior fragment (insert, fig. 43). These pins should not encroach on the line of fracture and should be placed close to the lower border of the mandible so as not to enter the mandibular canal. See pages 506 to 517.

Manipulate the three fragments into correct alinement and, while holding them in proper position, fasten the fixation rod to the pin units on either side of the jaw. (Note: The exact original continuity of the mandible may not be established by this method but the fractures can be reduced and immobilized well enough to obtain good bony union of the two fractures.)

If the fragments cannot be manipulated into approximation, elastic traction, as described on page 109, is necessary.

Maintain fixation for about four weeks.

Feed the patient a soft diet.

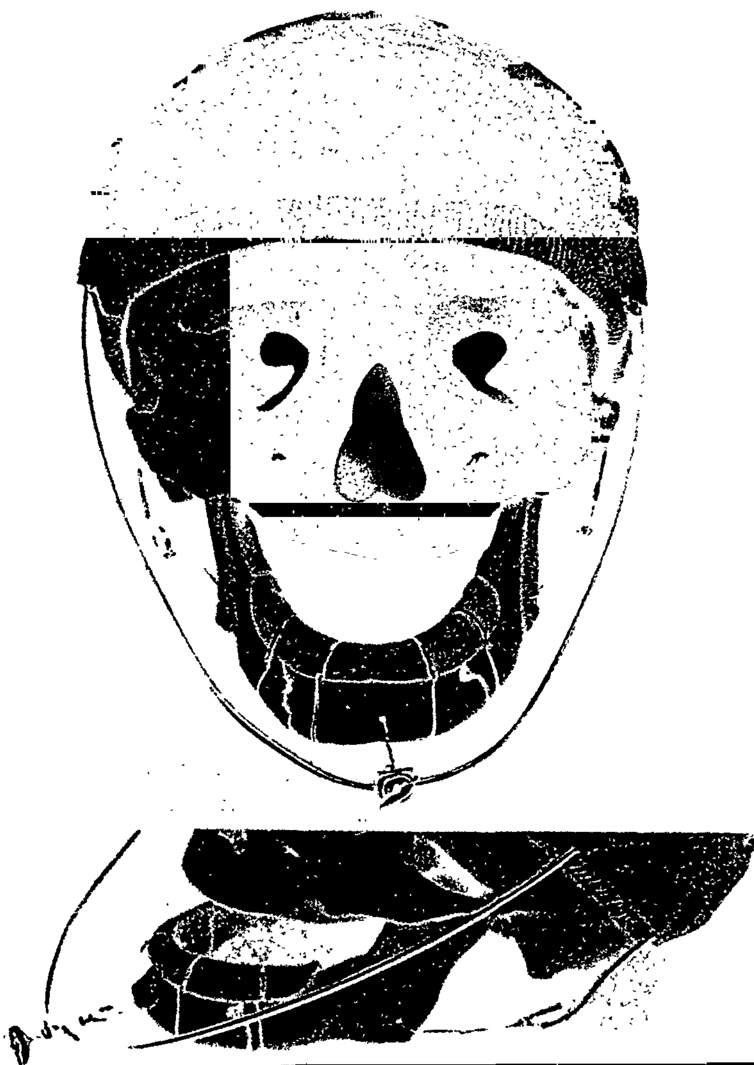


Fig. 44.—Text on pages 109 and 110.

TREATMENT OF OLDER FRACTURES BY ELASTIC TRACTION ATTACHED TO A PLASTER HEAD CAST (FIG. 44)

Through small incisions over the angles of the mandible and through one incision in the mental region, the angles and the lower border of the symphysis, respectively, are surgically exposed. A hole is drilled through the bone in these three locations and a double bronze, or stainless steel, 26 gauge wire is inserted through each hole. The incisions are sutured and the emerging wires are formed into loops for reception of rubber bands (not shown in fig. 44). See pages 540 to 549 for details of these surgical procedures.

Apply a plaster head cast with a hook emerging in each mastoid region; also incorporate in the head cast a heavy brass loop of wire bent in such a manner as to pass in front of the chin. See pages 479 to 495 for details of construction of head cast.

Stretch heavy rubber bands (not shown in fig. 44) between, on the one hand, the three wires that are attached to the bony fragments and, on the other hand, to the hooks and loop of wire that emerge from the head cast. When sufficient elastic traction has been applied, the overriding fragments will be pulled apart to such a degree that they can be manipulated into proper alinement.

If the fractures are situated in, or anterior to, the first molar region, we recommend using the patient's lower denture or an acrylic splint in conjunction with circumferential wires to immobilize the fragments. If the patient's lower denture is not available, an acrylic splint is prepared similar to the one described in Problem 4, page 43.

After the fragments have been pulled apart by elastic traction, insert the lower denture, or a prepared acrylic splint, over the lower alveolar ridge; then pass circumferential wires around the mandible for retention of the splint. Each posterior fragment should possess one circumferential wire and the anterior fragment two (fig. 44).

As soon as immobilization has been established by means of the splint and circumferential wires the plaster head cast and the wires inserted into the bony fragments can be removed.

If the fractures are located too far back in the body of the mandible to warrant use of this type of splint, or if the fractures are close to the angles, then we recommend the use of external pin fixation appliances for immobilization (fig. 43). The pin units and connecting bars should be securely attached before the plaster head cast and the wires that were inserted into the bony fragments are removed.

Maintain fixation for about four weeks.

Feed the patient a soft diet.

BILATERAL FRACTURE AT ANGLES OF DENTULOUS MANDIBLE (FIG. 45)

COMMENTS

In fractures of this type, the large anterior middle fragment, possessing teeth, is best immobilized by intermaxillary wires to insure normal dental occlusion. If the two posterior fragments are displaced forward by muscular traction, an external pin fixation appliance on either side supplements the intermaxillary wiring and immobilizes the posterior fragments.

Details of treatment are considered on page 113 and the illustration appears on page 112.

If the fractures are located too far back in the body of the mandible to warrant use of this type of splint, or if the fractures are close to the angles, then we recommend the use of external pin fixation appliances for immobilization (fig. 43). The pin units and connecting bars should be securely attached before the plaster head cast and the wires that were inserted into the bony fragments are removed.

Maintain fixation for about four weeks.

Feed the patient a soft diet.

TREATMENT BY INTERMAXILLARY WIRING AND BILATERAL EXTERNAL PIN FIXATION (FIG. 45)

Extract any tooth the root portion of which is exposed in the line of fracture.

If the two posterior fragments are displaced upward and forward by muscular traction, drive a single pin into the fragments on either side of the fractures. Because the middle fragment will be immobilized by intermaxillary wiring, one pin in each fragment is sufficient for immobilization. These pins should not encroach on the lines of fracture and should be placed along the lower border of the mandible so as not to enter the mandibular canal. See pages 506 to 517.

Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a hooked arch bar to the teeth of the lower jaw. See pages 526 to 528 for details.

Stretch rubber bands between the hooks of the upper and lower arch bars to bring the teeth into proper occlusion.

Replace the rubber bands with double intermaxillary wires passed over the arch bars rather than over the hooks.

Following immobilization of the anterior fragment by intermaxillary wiring, manipulate the two posterior fragments into proper position and immobilize by means of fixation rods attached to the pins on either side.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

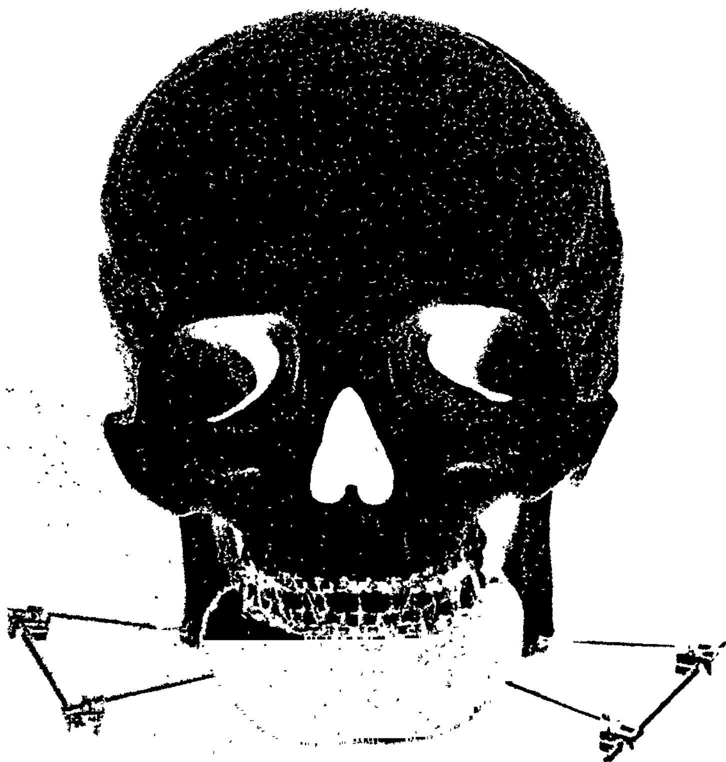


Fig. 45.—Text on page 113.

Bilateral Subcondylar Fractures of the Mandible (Figs. 46 and 47)

COMMENTS

Bilateral subcondylar fractures always produce some displacement of the body of the mandible. When teeth are present, some simple form of immobilization should be employed for about three weeks, in order that the mandible will assume its normal relationship to the upper jaw.

If there is marked displacement in an edentulous lower jaw, fixation by means of a Gunning splint is indicated. When the displacement is insignificant, however, there is no need of employing any form of fixation.

Details of treatment are considered on pages 117 and 119.

Illustrations on pages 116 and 118.

TREATMENT OF BILATERAL SUBCONDYLAR FRACTURES IN A DENTULOUS MANDIBLE. INTERMAXILLARY WIRES EMPLOYED (FIG. 46)

Immediate Care of Patient.—Bilateral subcondylar fractures produce little shock. However, when associated with a comminuted fracture of one or both glenoid fossae or of the tympanic plates, noticeable shock may develop and should receive prompt treatment. If the tympanic plate of either temporal bone is fractured, hemorrhage from the external auditory canal is likely to occur. This condition should be distinguished from a basal skull fracture.

Management of the Fracture.—Apply single loop (eyelet) wires to the teeth of the upper and lower dental arches. Three looped wires in each arc are sufficient.

After forcing the teeth into occlusion, connect the upper and lower wire loops (eyelets) by double intermaxillary wires.

If the middle dentulous fragment cannot be manipulated so that the lower teeth occlude properly with the upper dental arch, simple loop and intermaxillary wiring should not be employed. Instead, hooked arch bars and intermaxillary elastic traction are indicated. Such elastic traction gradually draws the teeth into occlusion. These rubber bands may be retained for immobilization of the mandible or may be replaced by double intermaxillary wires.

Maintain fixation for two or three weeks.

Feed the patient a liquid diet through a straw or glass tube.

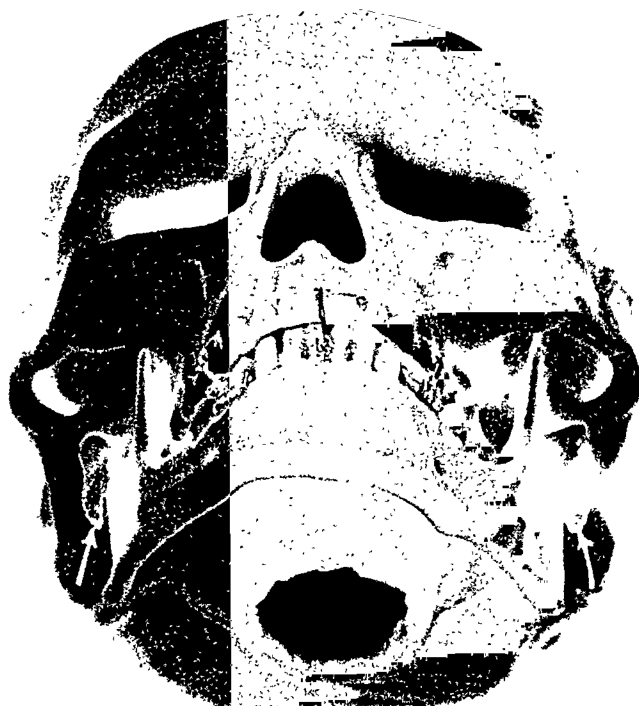


Fig. 46.—Text on pages 115 and 117.

TREATMENT OF BILATERAL SUBCONDYLAR FRACTURES IN AN EDENTULOUS MANDIBLE. GUNNING SPLINT EMPLOYED (FIG. 47)

Immediate Care of the Patient.—Same as that described on page 117.

Management of the Fracture.—If there is marked displacement of the mandible, it is well to employ a Gunning splint for two or three weeks to maintain the lower jaw in a more nearly normal position.

A Gunning splint can be constructed by wiring together the patient's dentures, from which two or three anterior teeth should be removed to facilitate feeding.

If the patient's dentures are not available, a Gunning splint can be constructed in the following manner:

1. Obtain impressions of both jaws in dental compound.
2. Prepare plaster models from these dental impressions.
3. Mount the two plaster models in normal relationship on a dental articulator.
4. Prepare a wax model for a Gunning splint. See figure 315*a*.
5. Prepare an acrylic splint from the wax model.

After placement of the Gunning splint in the mouth, some form of head bandage or chin sling is employed to hold the lower jaw up in proper relationship with the splint. (Note: This procedure does not effect perfect immobilization but does aid in maintaining the lower jaw in fairly normal position.)

Maintain fixation for two or three weeks.

Feed the patient a liquid diet through a straw or glass tube.

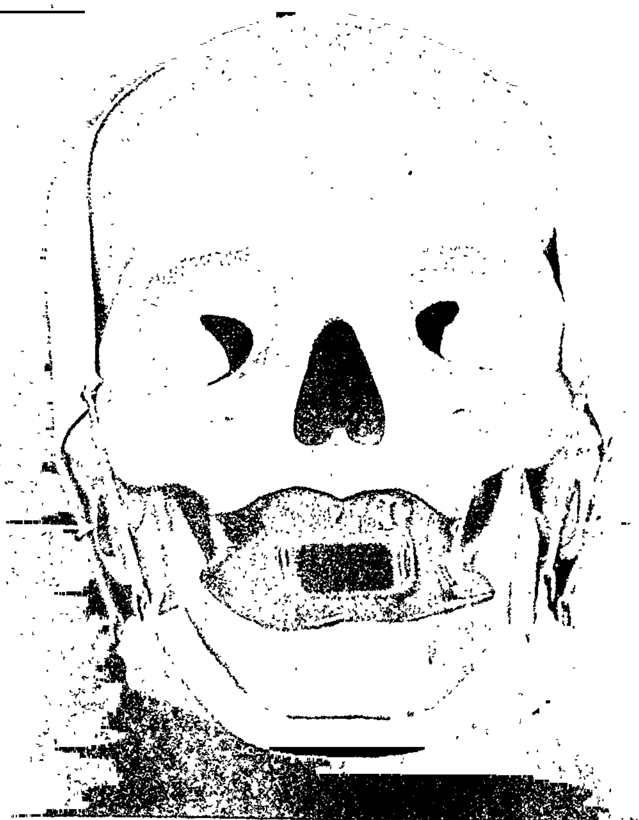


Fig. 47.—Text on pages 115 and 119.

Double Fracture of One Side of Mandible; One Fracture in the Molar Region and the Other in the Subcondylar Region (Figs. 48, 49 and 50)

COMMENTS

A not uncommon injury is a double fracture of one side of the mandible, there being one fracture in the bicuspid or molar region, associated with a subcondylar fracture on the same side. The middle fragment of bone between these two fractures usually is very much displaced mesially by muscular traction. Even when teeth are present in the anterior and middle fragments, it often is not easy to bring the middle fragment into proper relationship to the upper jaw by elastic traction. When teeth are absent in the middle fragment or in the entire lower jaw, then it frequently is extremely difficult to restore this fragment to its original position. The treatment which we advocate for such fractures is discussed in the following pages 123, 125 and 127.

Illustrations on pages 122, 124 and 126.

TREATMENT WHEN TEETH ARE PRESENT IN BOTH THE ANTERIOR AND MIDDLE FRAGMENTS (FIG. 48)

Extract every tooth the root portion of which is exposed in the line of fracture. If there is but a single tooth in the long posterior fragment, this tooth should be retained for fixation of the fragment even though its root is exposed. If such a tooth with an exposed root is retained, a through-and-through Penrose drain should be inserted close to the line of fracture, as was described in chapter I, pages 12 to 15.

Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a hooked arch bar to the teeth of the lower anterior fragment. Apply a molar band to a molar tooth in the middle fragment. See page 529 for details.

Stretch rubber bands between the hooks of the upper and lower arch bars and between the sheath of the lower molar band and the upper arch bar; such elastic traction gradually draws the teeth into proper occlusion and, in turn, reduces the fracture of the body of the mandible. Frequently elastic traction must be maintained for days before the fracture is completely reduced in a case of this type, and occasionally the middle fragment never can be restored to its exact original position.

The intermaxillary elastic bands may be retained for immobilization of the fracture if the patient can be seen frequently during the period of healing of the fracture, so that rubber bands can be replaced when broken. Otherwise, these rubber bands should be replaced by double intermaxillary wires passed over the arch bars rather than over the hooks of these bars.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

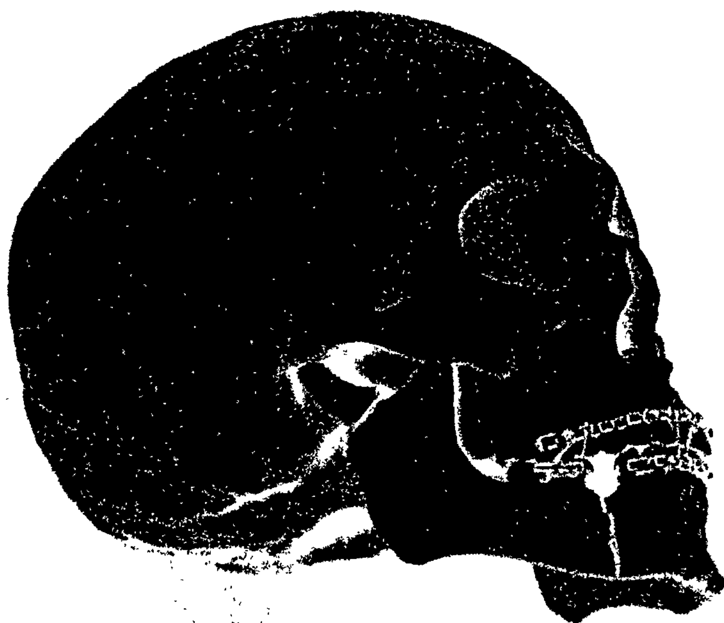


Fig 48—Text on pages 121 and 123.

TREATMENT WHEN TEETH ARE ABSENT FROM THE MIDDLE FRAGMENT (FIG. 49)

If the root of the tooth next to the line of fracture in the anterior fragment is exposed, this tooth should be extracted.

In a case of double fracture of the mandible such as is being discussed here, in which the middle fragment is edentulous, it is very difficult to maintain the middle fragment in correct alinement. External pin fixation is of no advantage over a cast silver splint with circumferential wiring (fig. 49).

To prepare such a splint:

1. In dental compound obtain impressions of the upper and lower dental arches.
2. Prepare plaster models from these impressions.
3. Saw through the lower model at the site of the anterior fracture.
4. Mount the lower plaster segments and the upper model in proper relationship on a dental articulator.
5. Prepare a wax model of the splint, which should fit over the teeth in the anterior fragment and which possesses a flange or saddle for the alveolar ridge of the middle fragment.
6. Cast a silver splint from the wax model.

Cement the silver splint to the teeth of the anterior fragment and manipulate the middle fragment into proper position below the flange of the splint. Apply one circumferential wire around the middle fragment and over the flange for immobilization of this fragment.

Attach intermaxillary rubber bands to hooks on the silver casting and to a hooked arch bar above. Bring the splint and lower fragments into proper relationship to the upper dental arch.

Replace the intermaxillary rubber bands with double intermaxillary wires.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 49 – Text on pages 121 and 125.

TREATMENT WHEN THE ENTIRE MANDIBLE IS EDENTULOUS (FIG. 50)

In a case of double fracture of one side of an edentulous mandible, reduction is difficult and fixation of the middle fragment in proper position is a problem. When the fragments can be easily manipulated into correct alinement, fixation is most satisfactory when the patient's lower denture, or an acrylic splint with circumferential wires, is employed (fig. 20).

If manual reduction of the fracture is difficult, such a splint is likely to produce much irritation of the lower alveolar ridge because of the pressure exerted by the splint in preventing the fragments from springing back into their displaced position. Under these circumstances, external pin fixation is advisable. Furthermore, skeletal traction is to be recommended when the fracture is situated posterior to the first molar region, leaving a very short posterior fragment. When employing direct skeletal fixation for a double fracture of this type, we follow the technic described below:

Insert a two-pin unit (two pins joined together with a connecting bar) in the anterior and in the middle fragment. These pins should not encroach on the line of fracture and should be placed close to the lower border of the mandible so as not to enter the mandibular canal. See pages 506 to 517 for details.

Manipulate the anterior and middle fragments into proper relationship and, while holding them in the desired position, have a connecting bar applied to join the pin units in the anterior and middle fragments.

Maintain fixation for three or four weeks.

Feed the patient a soft diet.



Fig. 50 — Text on pages 121 and 127.

Multiple Fractures of Mandible. Teeth Present in Mandible and Maxilla (Fig. 51)

COMMENTS

Three or four fractures lying more or less at right angles to the long axis of the mandible do not complicate the problem of treatment if the majority of teeth of the lower jaw are still present (fig. 51). In fact, these fractures are treated much the same as bilateral fractures of the mandible. It is well to bear in mind that a patient who has sustained several fractures of the lower jaw is likely to show definite signs of shock, and this condition should receive the first consideration in care of the patient.

Treatment is considered on page 131.

Illustration on page 130.

TREATMENT BY INTERMAXILLARY TRACTION AND EXTERNAL PIN FIXATION (FIG. 51)

Immediate Care of the Patient.—A patient with several fractures of the mandible may give definite evidence of shock. This condition should be treated and controlled before any detailed examination or treatment of the fractures is undertaken.

Management of the Fracture.—Extract any tooth the root portion of which is exposed in the line of fracture. However, if there is present but a single tooth in the posterior fragment, this tooth should be retained for fixation of the fragment even though its roots may be exposed. Under these circumstances, a through-and-through Penrose drain should be inserted close to the line of fracture, as was described in chapter I, page 12.

Wire hooked arch bars to all teeth in the upper dental arch. Attach a segment of a hooked arch bar to the several teeth in the lower anterior fragment. Since there are only one or two molar teeth in the posterior fragments, an anchor clamp band having a buccal sheath is attached to a molar tooth in each of these fragments. See page 529 for details.

If a fragment posterior to the fracture, at the angle, is displaced forward, this is best immobilized by external pin fixation. Drive a single pin into each fragment formed by the fracture at the angle. See pages 506 to 517 for details.

Stretch rubber bands between the hooks of the upper and lower arch bars and between the upper arch bar and the sheaths of the two lower molar bands; such elastic traction gradually draws the teeth into proper occlusion and in turn reduces the fractures of the body.

Replace the intermaxillary rubber bands with double intermaxillary wires for immobilization of the dentulous fragments.

Manipulate the fragment posterior to the angle fracture into proper position and immobilize by means of a fixation rod which is fastened to the two pins.

Maintain fixation for about four weeks. The pin fixation appliance can be removed in three weeks, if desirable.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 51 - Text on pages 129 and 131.

Multiple Fractures of the Mandible. Some Fragments Edentulous (Figs. 52 and 53)

COMMENTS

Multiple fractures of the mandible in which some of the fragments are edentulous offer a difficult problem in immobilization. In figure 52 it will be noted that, in addition to fractures of the body of the mandible, there exists a fracture close to either angle. On the left side, the ramus is pulled forward and overrides the rather long fragment of the body of the mandible. On the opposite side, however, the right ramus is displaced over a rather short fragment of the body of the mandible. On the left side, the fracture at the angle could well be immobilized by means of an external pin fixation appliance because the fragments are of sufficient length to permit of insertion of pins. However, for use on the right side, we would disapprove very strongly of an external pin appliance because it would be almost impossible to insert a pin into the fragment just anterior to the fracture of the angle without encroaching on the line of fracture. Under such circumstances, infection around the pin would be a probable complication which in turn might cause sequestration of this entire fragment. To complicate the problem of fixation of the right ramus is a subcondylar fracture on the right side. Because of this fracture, even surgical insertion of a wire in the right ramus, to be attached to a plaster head cast, would be of no value since it would not pull this fragment back into proper position. As far as the fracture at the right angle of the jaw is concerned, the fragments cannot be immobilized safely either by external pin fixation or by traction to the plaster head cast. Accordingly, there is really no treatment available for immobilization of these fragments at the angle. Consequently, we would attempt neither to reduce nor to immobilize the angular fracture; it should be left undisturbed to heal by bony or fibrous union. Treatment for the other elements of the multiple fractures which constitute the present problem has been mentioned and will be explained in detail (fig. 53) on pages 135 and 136.



Fig. 52.—Text on page 133.

TREATMENT BY INTERMAXILLARY WIRING, A CAST SILVER SPLINT, AND EXTERNAL PIN FIXATION (FIG. 53)

Immediate Care of the Patient.—A patient with multiple fractures of the mandible, such as are described here, will present definite signs of shock. This condition should be treated and controlled before any detailed examination or treatment of the fractures is undertaken.

Management of the Fracture.—If the root of a tooth in the anterior fragment is exposed in a line of fracture, this tooth should be extracted.

Since there is comminution of the right side of the mandible, it is advisable to insert a through-and-through Penrose drain in this region and to retain it in place for two weeks, as was described in chapter I, pages 12 to 15.

With dental compound obtain impressions of the upper and lower dental arches.

Prepare plaster models from these impressions.

Cut the lower plaster model at the sites of the fractures of the body of the mandible.

Mount the lower plaster fragments and the upper plaster model in relatively normal relationship on a dental articulator.

Prepare a wax model for a silver splint which should fit over the teeth in the anterior fragment and should possess a saddle to lie over the edentulous fragments on the right side of the lower jaw.

Cast a silver splint from the wax model. The labial surface of that portion of the splint which covers the lower teeth should be made with buttons or hooks for the attachment of intermaxillary rubber bands or wires.

The fracture at the left angle of the mandible can best be immobilized by external pin fixation. Insert one pin into each fragment on either side of this fracture.

Cement the cast silver splint to the teeth in the lower anterior fragment. If the splint is not perfectly stable, circumferential wires can be employed to insure thorough fixation of the splint to the anterior dentulous fragment.

Circumferential wires should not be passed around the small fragments in the right side of the lower jaw or over the saddle portion of the splint because the wires are likely to slip into

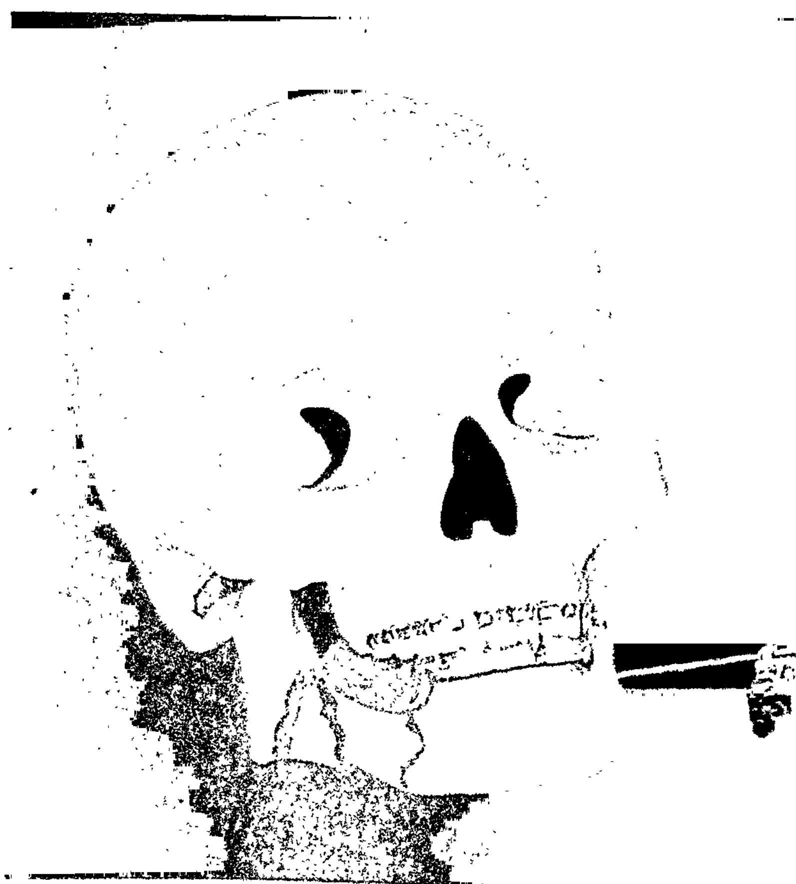


Fig. 53. Text on pages 135 and 136

Problem 21 is discussed on page 139.

Stretch rubber bands from the upper arch bar to the buttons or hooks on the silver splint below; such elastic traction elevates the splint and lower anterior fragment into proper position with the upper dental arch. These rubber bands should be replaced by double intermaxillary wires.

Following immobilization of the dentulous fragment of the mandible, manipulate the left ramus into proper alinement and immobilize by means of a fixation rod which is fastened to two pins.

Apply a thick strip of felt to the chin and stretch loose rubber bands from the ends of this felt to a head bandage above (fig. 47). These elastic bands, acting on the strip of felt, gradually elevate the small fragments on the right side of the lower jaw until they come in contact with the saddle portion of the splint. By this arrangement, the numerous fragments on the right side will not necessarily be returned to their original position but will be partially immobilized. It is our belief that such treatment offers the safest form of therapy in the care of these small fragments; more radical treatment is likely to result in complications such as necrosis of bone or sequestra. Furthermore, bony union may not develop in all of the lines of fracture in the right side of the mandible but it is probable that formation of scar tissue around these small fragments will permit of normal function of the jaw.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

(Note: Should nonunion of one or more of the fractures on the right side of the mandible occur, and if function of the jaws is markedly disturbed, a bone graft is indicated after the lapse of several months.)

Multiple Mandibular Fractures, One or More of Which Pass Obliquely across the Body of the Mandible (Figs. 54 and 55)

COMMENTS

Multiple fractures of the mandible in which one or more fractures pass obliquely through the substance of the body of the mandible are not of uncommon occurrence. Such oblique fractures often involve the roots of several teeth which need be extracted, thereby increasing the difficulties of fixation of the fragments. In a case such as the one pictured in figure 54, there are several small, edentulous fragments anteriorly which require immobilization; their fixation by means of external pins is not desirable because pins inserted into such small fragments are very likely to extend into one or more lines of fracture and to expose the bone surrounding them to infection. In a situation of this type, we urge the use of a more conservative and safer type of immobilization, such as is described in relation to figure 55 and on page 141.



Fig. 58. Text on page 139.

TREATMENT BY INTERMAXILLARY WIRING IN CONJUNCTION WITH A LOWER CAST SILVER SPLINT AND CIRCUMFERENTIAL WIRES (FIG. 55)

Immediate Care of Patient.—A patient with multiple fractures of the mandible, such as are described here, is likely to present definite signs of shock. This condition should be treated and controlled before any detailed examination or treatment of the fractures is undertaken.

Management of the Fracture.—Extract all teeth the roots of which are involved in the oblique line of fracture.

Obtain impressions in dental compound of the upper and lower dental arches.

Prepare plaster models from these impressions.

Cut the lower plaster model at the sites of the fractures.

Mount the lower plaster fragments and the upper plaster model in normal relationship on a dental articulator.

Prepare a wax model for a silver splint; this model should fit over the teeth in the posterior fragments and over the alveolar ridge of the anterior, edentulous fragments.

Cast a silver splint from the wax model.

Place the silver splint over the lower teeth and immobilize by circumferential wires passed around the mandible to metal loops on the splint. Manipulate the anterior, edentulous fragments into proper position with the splint and immobilize them by circumferential wires. See page 533 for details.

With proper attachment of the splint, intermaxillary wiring usually is unnecessary. However, in the construction and application of such a splint, minor discrepancies in alinement of the fragments are bound to occur. Consequently, on removal of the splint in three or four weeks, occlusion of the teeth may not be perfectly accurate. This disturbance in dental occlusion, still at this late period can be corrected by intermaxillary elastic traction in the following manner:

Attach an anchor clamp band, having a buccal sheath, to a molar tooth on either side of the lower jaw, and wire a hooked arch bar to the teeth in the upper dental arch. Stretch rubber bands between the hooks of the upper arch bar and the sheaths of the lower molar bands; such elastic traction gradually pulls the teeth into more natural occlusion.

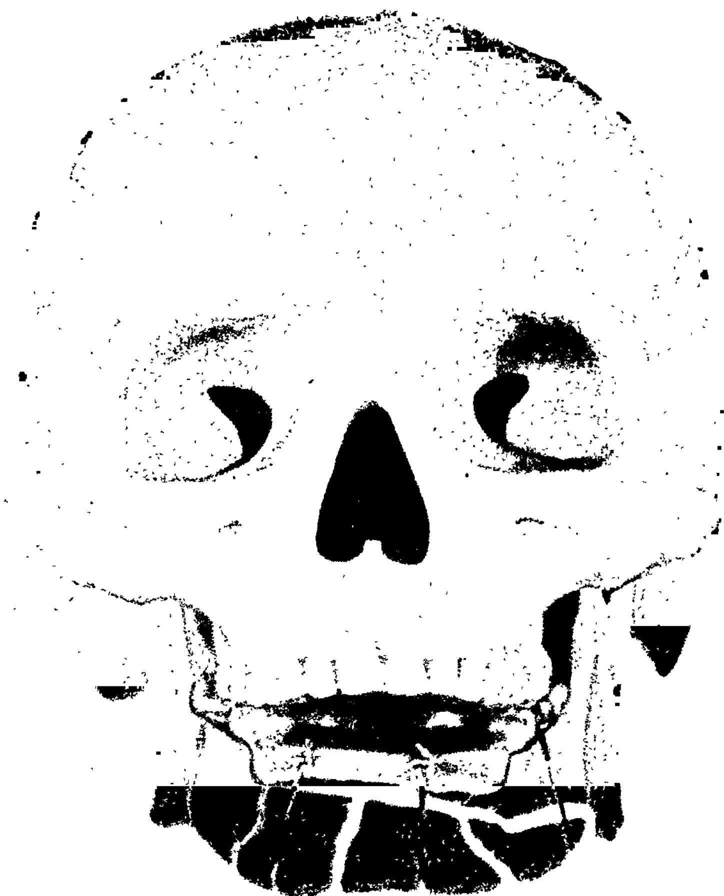


Fig. 55. Text on pages 139 and 141.

Multiple Fractures of an Edentulous Mandible (Figs. 56 and 57)

COMMENTS

In cases of multiple fracture of an edentulous mandible, we believe it is preferable not to employ external pin fixation unless one of the lines of fracture is situated close to the angle and then only when the fragments are sufficiently large to allow insertion of pins without entering a line of fracture. Wherever it is possible to use the patient's lower denture or an acrylic splint with circumferential wires, it is our opinion that this method of immobilization is the safest, and the most comfortable for the patient.

Details of treatment are considered in pages 145 and 147.

Illustrations on pages 144 and 146.

Multiple Fractures of an Edentulous Mandible (Figs. 56 and 57)

COMMENTS

In cases of multiple fracture of an edentulous mandible, we believe it is preferable not to employ external pin fixation unless one of the lines of fracture is situated close to the angle and then only when the fragments are sufficiently large to allow insertion of pins without entering a line of fracture. Wherever it is possible to use the patient's lower denture or an acrylic splint with circumferential wires, it is our opinion that this method of immobilization is the safest, and the most comfortable for the patient.

Details of treatment are considered in pages 145 and 147.



Fig. 56. Text on pages 143 and 145

TREATMENT BY EXTERNAL PIN FIXATION (FIG. 56)

Immediate Care of Patient.—A patient with multiple fractures of the mandible, such as are described here, may show definite signs of shock. This condition should be treated and controlled before any detailed examination or treatment of the fractures is undertaken.

Management of the Fracture.—In an edentulous jaw with multiple fractures, such as is illustrated in figure 56, external pin fixation offers the most satisfactory means of immobilization. Skeletal traction is particularly desirable here, because it would be almost impossible adequately to immobilize the right ramus, situated between the angle and subcondylar fractures, by any other method. Moreover, the fragments are of sufficient size so that pins can be inserted without encroachment on the lines of fracture. (Note: Were the fragments very small, so that pins could not be inserted without entering a line of fracture, then we would not recommend skeletal traction as a method of fixation in this case. Under these circumstances, it would be preferable to employ an acrylic splint with circumferential wires to immobilize the fracture on the left side of the mandible, and to attempt immobilization of the right ramus by inserting, near the angle of this fragment, a wire which would be attached to a plaster head cast.)

Drive pins into the bony fragments, as is illustrated in figure 56. These pins should not encroach on the line of fracture, and should be placed close to the lower border of the mandible so as not to enter the mandibular canal. See pages 506 to 517.

Manipulate two fragments at a time into correct alinement. While holding them in proper position, fasten a fixation rod to the pin units in order to secure immobilization of these fragments. Then proceed with the manipulation and fixation of the remaining fragments.

Fixation should be maintained for about four weeks.

Feed the patient a liquid or semisoft diet.



Fig. 57. Text on pages 145 and 147

TREATMENT BY ACRYLIC SPLINT AND CIRCUMFERENTIAL WIRES (FIG. 57)

Immediate Care of Patient.—Same as that described on page 145.

Management of Fracture.—Employ the patient's lower denture as a splint if it is available; otherwise construct an acrylic splint as follows:

1. Obtain impressions in dental compound.
2. Prepare plaster models from these impressions.
3. Cut the lower plaster model as well as possible at the sites of the fracture.
4. Mount the plaster fragments and the upper plaster cast in relatively normal position on a dental articulator.
5. Prepare a wax model for a lower acrylic splint.
6. Construct an acrylic splint from the wax model.

Insert the acrylic splint in the mouth and manipulate the fragments into proper position with the splint. Pass circumferential wires around each fragment and over the splint, which has been grooved for reception of these wires.

It is not advisable in a case of this type, in which the fragments are small, to employ external pin fixation because the fragments are so small that one or more pins on insertion are likely to enter a line of fracture; under these circumstances, infection of the surrounding bone and possible sequestration are potential sequelae. However, should a fracture at the angle be present in a case of this type, external pin fixation might be employed in the immobilization of the involved ramus.

Maintain fixation for about four weeks.

Feed the patient a soft diet.

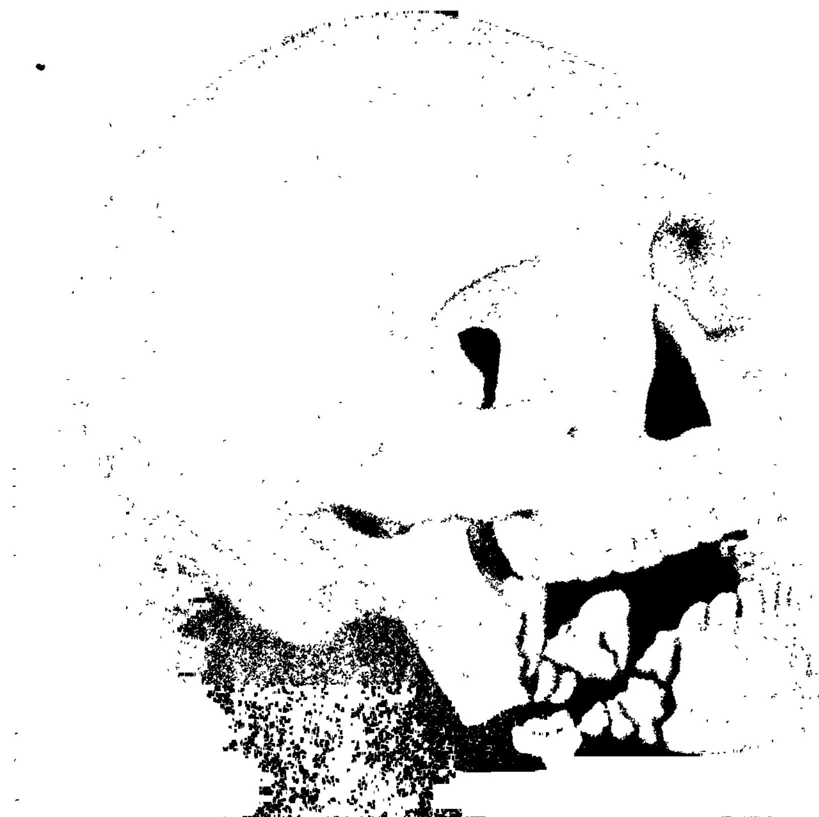


Fig. 58. Text on page 146.

Severe Comminution of a Portion of the Mandible (Figs. 58 and 59)

COMMENTS

If a portion of the mandible is severely comminuted, as it may be when injured by shrapnel or a bullet, it is likely that sequestration of some of the fragments will occur and, eventually, loss of bone. Under these circumstances, a bone graft will become necessary if continuity of the mandible is to be re-established. Consequently, in any injury of this type treatment should consist of measures which will facilitate ultimate insertion of a bone graft. Early immobilization of the unaffected parts of the mandible is most essential if the normal relationship of the dentulous fragments to the upper dental arch is to be maintained.

Details of treatment are discussed on page 151

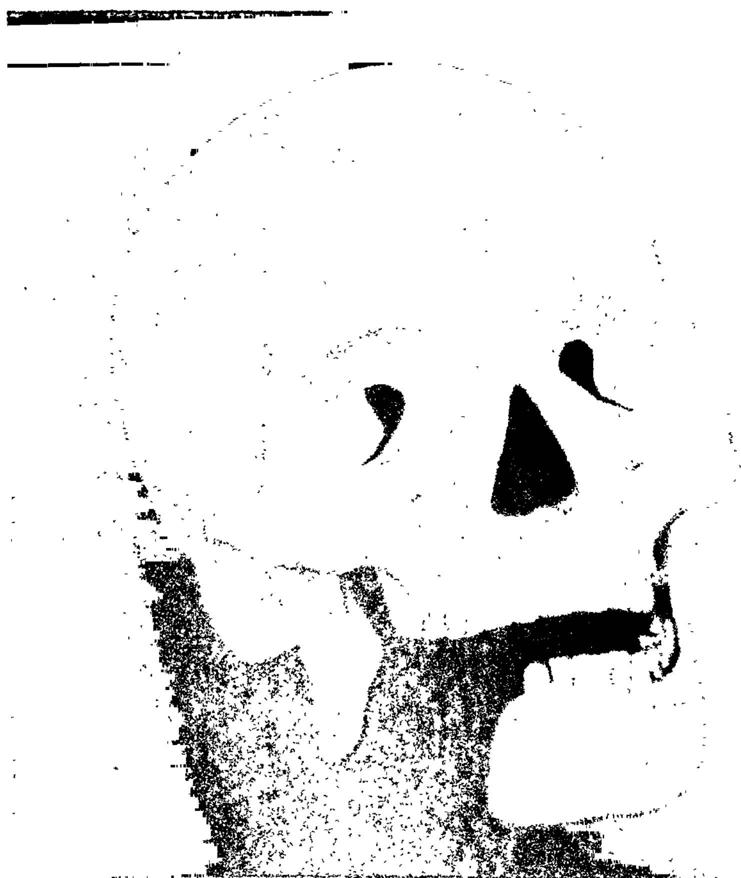


Fig. [illegible]. Text on page 151

TREATMENT PREPARATORY TO BONE GRAFTING (FIG. 59)

Immediate Care of Patient.—A patient with an injury of the type considered in this problem may show definite symptoms of shock and this condition should be treated promptly before any maxillofacial examinations or treatments are undertaken.

Management.—Comminution of the mandible often is associated with external wounds of soft tissue, which should be cleansed and sutured as soon as the patient's general condition will permit. Such wounds of soft tissue, however, should not be tightly closed without inserting one or more Penrose drains.

During treatment of the soft tissues, all damaged teeth and loose pieces of bone that are completely detached should be removed. It always is advisable to cleanse the intra-oral wound with hydrogen peroxide, to apply one of the sulfa drugs locally and to insert through-and-through Penrose drains in the region of the comminuted bone. See pages 12 to 15.

After a period of two or three weeks, if the intra-oral swelling has disappeared, upper and lower dental impressions should be obtained. From such impressions can be constructed a splint to maintain dentulous fragments in proper position (fig. 59). Just what type of splint is required in each case depends entirely on the number and position of teeth remaining in the lower jaw; the various available splints for this purpose are described in chapter VIII, on bone grafts.

The through-and-through Penrose drain usually is retained until drainage from the wound disappears, often a matter of two or three weeks.

Sequestra of bone which may develop should not be disturbed until entirely loose; their complete separation sometimes requires one to three months, or even longer.

Bone grafting should not be considered for at least six months after all symptoms of infection (that is; pain, swelling, discharge or sequestra) have entirely disappeared.

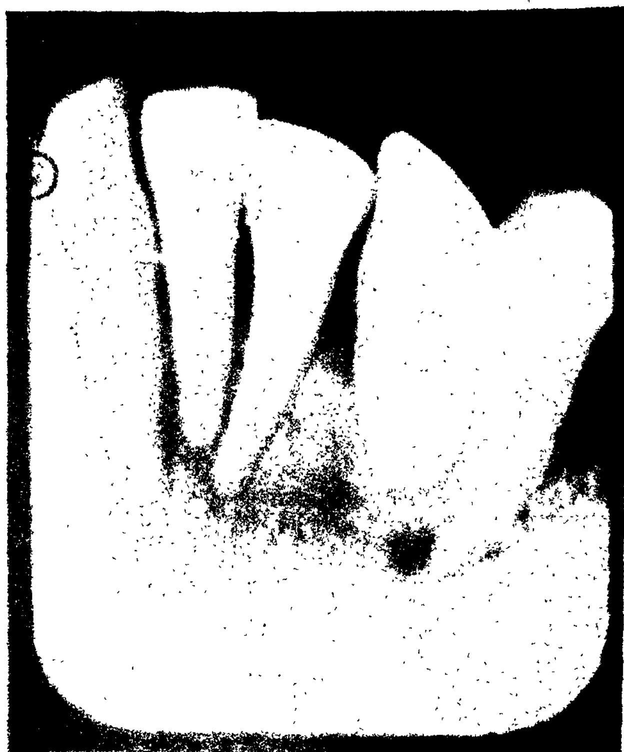


Fig. [illegible].—Text on page 153

Fracture of Alveolar Process of Mandible (Fig. 60)

COMMENTS AND TREATMENT

Occasionally fractures of the mandible occur in which the line of fracture assumes a horizontal course and involves only the alveolar process. The treatment here is based entirely on the relationship of the line of fracture to the roots of the teeth. If the fracture passes across the occlusal or incisal half of the dental roots, no treatment is required and the teeth may be retained. However, if the line of fracture is situated close to the apices of the dental roots. as in figure 60, there is danger of necrosis of the pulp of these teeth because their blood supply has been cut off or disturbed. Under these circumstances, the involved teeth should be extracted and the loose bone intervening between them often is better removed as well.



Fig. 61.—Text on page 155

Mandibular Fractures in Which Teeth Are Present in Lower Jaw but Not in Maxilla (Fig. 61)

COMMENTS AND TREATMENT

It is rather uncommon to encounter one or more fractures of a dentulous mandible, in the presence of a corresponding edentulous maxilla. This condition produces a difficult problem in immobilization because there are no upper teeth to which intermaxillary wires can be attached. In cases of this character, with teeth present in both fragments, we employ for fixation a cast silver splint such as is described on pages 561 to 578. Such splints do not require the use of intermaxillary wires for immobilization of the fragments.

If one fragment is edentulous, or if the fracture is situated close to the angle of the lower jaw, then external pin fixation is the ideal method of immobilization.

When a subcondylar fracture exists, treatment requires use of the patient's upper denture; the lower jaw is manipulated in such a manner that the lower teeth are forced into occlusion with the artificial teeth of the upper plate, and immobilization of the mandible is accomplished by some form of bandage or elastic chin sling.



Fig. 62.—Text on page 157

UNUNITED FRACTURES OF THE MANDIBLE (FIG. 62)

COMMENTS AND TREATMENT

The main etiologic factors which contribute to nonunion in cases of fracture of the mandible are, first, poor approximation of the fragments, and, second, suppuration due either to necrosis of dental pulp or to sequestra of bone. These facts should emphasize the importance of extracting all teeth the roots of which are exposed in a line of fracture; of removing loose pieces of bone which are completely detached from the remaining portion of the jaw bone, and of attempting to acquire proper approximation of the fracture surfaces.

In addition to poor approximation and suppuration, many systemic factors have been suggested as causes of ununited fracture; some of these are rather theoretical and all are indefinite, complicated and difficult to understand.

It is our belief that if bony union does not develop in a fracture of the mandible after the fragments have been immobilized for two months, union is not going to occur thereafter. In these cases, we have adopted the following treatment: All fixation appliances are removed. Then, through a small, intra-oral incision a small curet is employed to remove all of the fibrous tissue which has developed in the line of fracture. We have found that such management favors development of bony union. There is likely to be very little displacement of fragments, even though the fixation appliances have been removed, because sufficient scar and fibrous tissue previously have formed in the soft tissues adjacent to the fracture to hold the fragments in fairly good alinement. It has been our observation that in such cases of ununited fracture, bony union will develop after curettement with greater certainty if no form of fixation whatsoever is employed

CHAPTER III

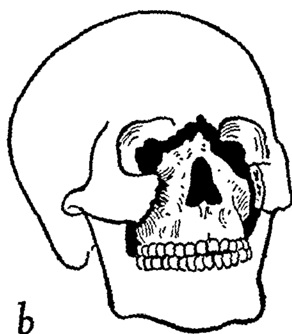
FRACTURES OF THE MAXILLA

AS a matter of convenience in discussing the therapeutic management of fractures of the upper jaw, we have found it advantageous to classify such fractures in four groups:

1. Fractures by which the upper jaw is completely separated from the rest of the skull.
2. Transverse fractures of the maxilla associated with one or more fractures of the palate.
3. Unilateral fractures of the upper jaw.
4. Simple fractures of the upper alveolar process.



a



b



c

Fig. 63.—Text on page 161.

FRACTURES BY WHICH THE UPPER JAW IS COMPLETELY SEPARATED FROM THE REST OF THE SKULL (FIGS. 63 TO 74 INCLUSIVE)

COMMENTS

Three Types of Fractures.—It is advisable to consider three forms of fractures which produce complete separation of the maxillae from the rest of the skull. As is illustrated in figure 63*a*, the *first* and most common type is the horizontal or transverse fracture of the upper jaw, in which the greater portion of the maxilla is detached as a free segment. The *second* type, not infrequently encountered, is the pyramidal facial fracture (so-called because it assumes the form of a pyramid) which extends upward through each antrum to the ethmoid region and the base of the nose (fig. 63*b*). In this form, the loose fragment is composed of the entire maxilla and the nasal bones. Pyramidal facial fractures are often associated with a depressed or comminuted fracture of one malar bone. Of rare occurrence is the *third* type, which may be described as a transverse facial fracture passing through the base of the nasal and ethmoid regions and across the orbits to the zygomatic arches. (fig. 63*c*). This fracture is of such character that the upper jaw, malar and nasal bones constitute one complete displaced structure. As would be expected, the last type of fracture is of extremely uncommon occurrence because it almost invariably is present in conjunction with depressed fractures of both malar bones and, under such circumstances, the facial injury actually is converted into a combination of a pyramidal facial fracture and a transverse facial fracture. The fact should not be overlooked that two, or all three, of these fractures may exist together in the same case (fig. 64). Moreover, fractures of the malar, nasal and ethmoid bones are frequently encountered in connection with severe fractures of the upper jaw.

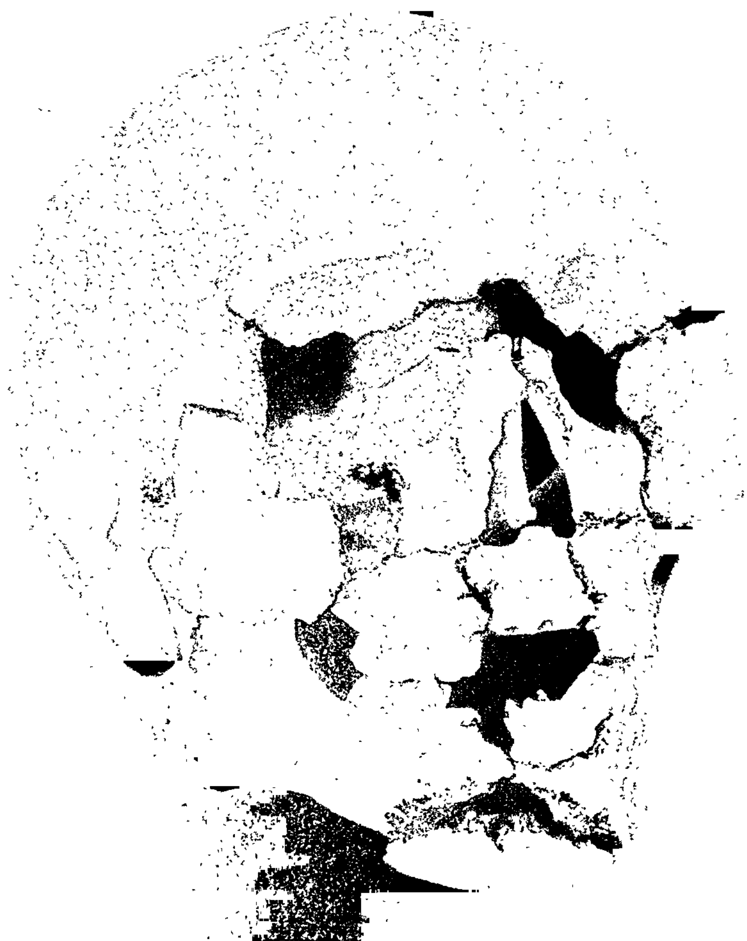


Fig. 64.—Text on page 161.

COMMENTS (*Continued*)

Immediate Care of Patient.—The immediate care of any patient with one or more of the three types of fractures under consideration here should proceed in the following manner: First, treatment should be directed toward control of shock, which may be a serious condition when it is associated with fracture of the ethmoid bone. Following such therapy, the nose should be examined to determine whether or not cerebrospinal fluid is draining from one or both nasal cavities, a symptom which indicates the presence of a fractured ethmoid bone. It frequently is difficult to distinguish between cerebrospinal fluid draining from the nose and ordinary nasal mucus. A simple and effective method of differentiation was described in chapter I. According to this method, the patient should be placed in such a position that any discharge from the nose will drain onto a clean handkerchief. If the secretion is mucus it will stain the handkerchief and will change the texture of the material so that it appears to be starched. On the other hand, if the secretion is cerebrospinal fluid it will stain the handkerchief but will not change the texture of the cloth.

On completion of the nasal examination, the immediate care of the patient should continue with roentgenologic study of the facial bones. As was discussed in chapter I, if the roentgenogram reveals spicules of bone in the ethmoid region protruding upward into the substances of the brain, the patient should be referred to a neurosurgeon for surgical removal of these bony spicules. Any injuries or lacerations of the overlying soft tissues of the face should be taken care of under local anesthesia as soon as the patient's general condition will permit.

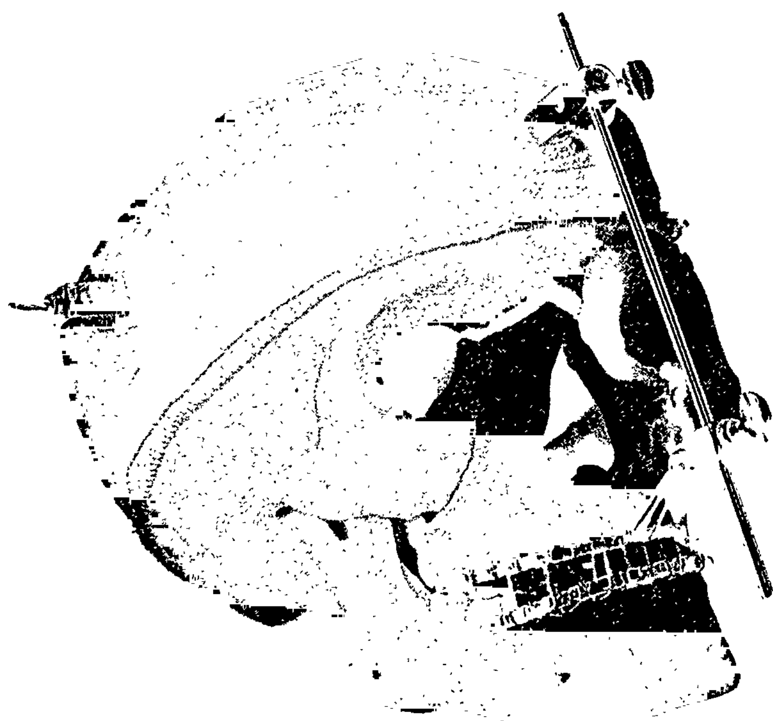


Fig. 65.—Text on page 169.

COMMENTS (*Continued*)

Diagnosis.—In the course of the examinations, clinical and roentgenologic, which were necessary to the immediate care of the patient, considerable progress will have been made toward diagnosis. Any necessary further clinical or roentgenologic examination now can be made.

Although the three fractures which have been described possess definite anatomic differences, the objective, intra-oral findings are often indistinguishable. Clinically, the upper jaw is loose, movable and more or less displaced so that the teeth do not occlude properly. However, in a case of transverse maxillary fracture, there is a tendency for the upper jaw to be forced upward and backward, with a resultant open bite type of deformity. Pyramidal facial fractures and transverse facial fractures, on the other hand, are likely to cause downward displacement of the upper jaw, with varying degrees of malposition between the upper dental arch and the lower teeth. In such instances, roentgenograms frequently reveal a space several millimeters in width between the upper border of the nasal bones and the glabella portion of the frontal bone.

By determining which fracture, or which combination of these fractures, exists in each case, the difficulty which will be encountered in reduction can be predicted with fair accuracy. In cases of pyramidal fracture or transverse facial fracture, reduction is usually a much more difficult task than in cases of simple transverse maxillary fracture. Furthermore, the preoperative diagnosis of the type of fracture present is of value in ascertaining the gravity of the injury.

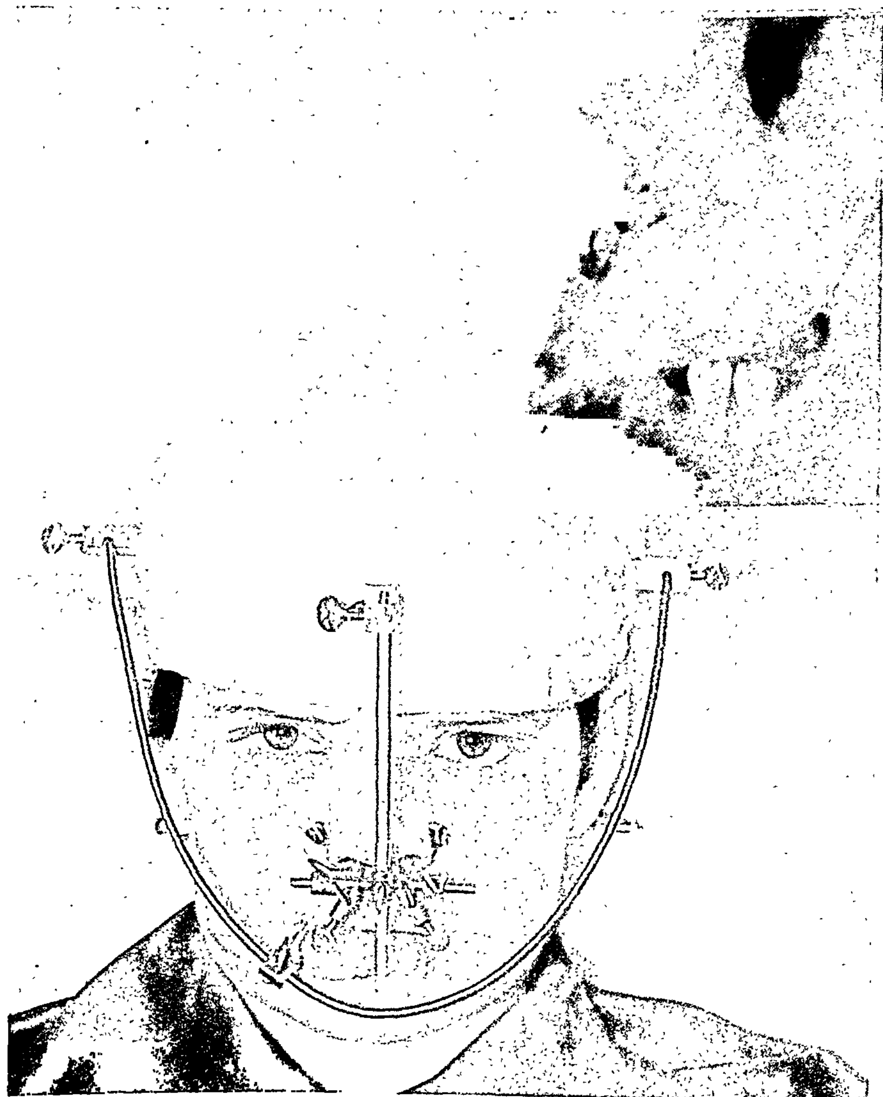


Fig. 66.—The rubber band mentioned in the text, on page 169, protrudes from the right corner of the mouth.

COMMENTS (*Continued*)

Treatment in General.—Although the details of treatment for the three types of fractures which produce complete separation of the upper jaw from the rest of the skull are discussed on pages 177, 179, 181 and 183, we believe that a general description of the treatment which we employ should be considered at this point in the text in order that it may be compared with other methods of therapy.

If an associated fracture of the ethmoid bone, such as has been mentioned, is present, it is extremely important not to treat the fractured facial bones for from ten to fourteen days after the injury, because any manipulation of these bones may disturb the fracture of the ethmoid bone and induce meningitis. As was discussed in chapter I, the fracture in the ethmoid region becomes walled off to a certain extent by fibrous tissue during the interval of two weeks, and it is then safe to proceed with treatment of the fractured facial bones. Again, we would like to stress the importance of administering one of the sulfa drugs during the interval of ten to fourteen days as an aid in prevention of meningitis. In the absence of ethmoidal injury, usually the fractures of the bones of the face can be treated as soon as signs of shock, if present, have subsided.

As applies to all fractures, treatment of injuries of the facial bones which are associated with complete separation of the upper jaw from the rest of the skull consists first in reduction and later in immobilization of the parts involved. Reduction of these fractures, in general, is effected with the aid of mechanical appliances which restore the teeth to their normal and original occlusion. Even though the upper jaw is freely movable, in most instances it is not possible to manipulate it into correct position. On the contrary, usually dependence must be placed on elastic traction to secure satisfactory reduction of the fracture and normal occlusion of the teeth. The gradual, continuous pull of rubber bands, when applied in the right direction, invariably will restore a displaced upper jaw to its proper position, whereas the ultimate result would be more or less of a failure if one attempted manually to replace the fractured maxillae in accurate alinement.

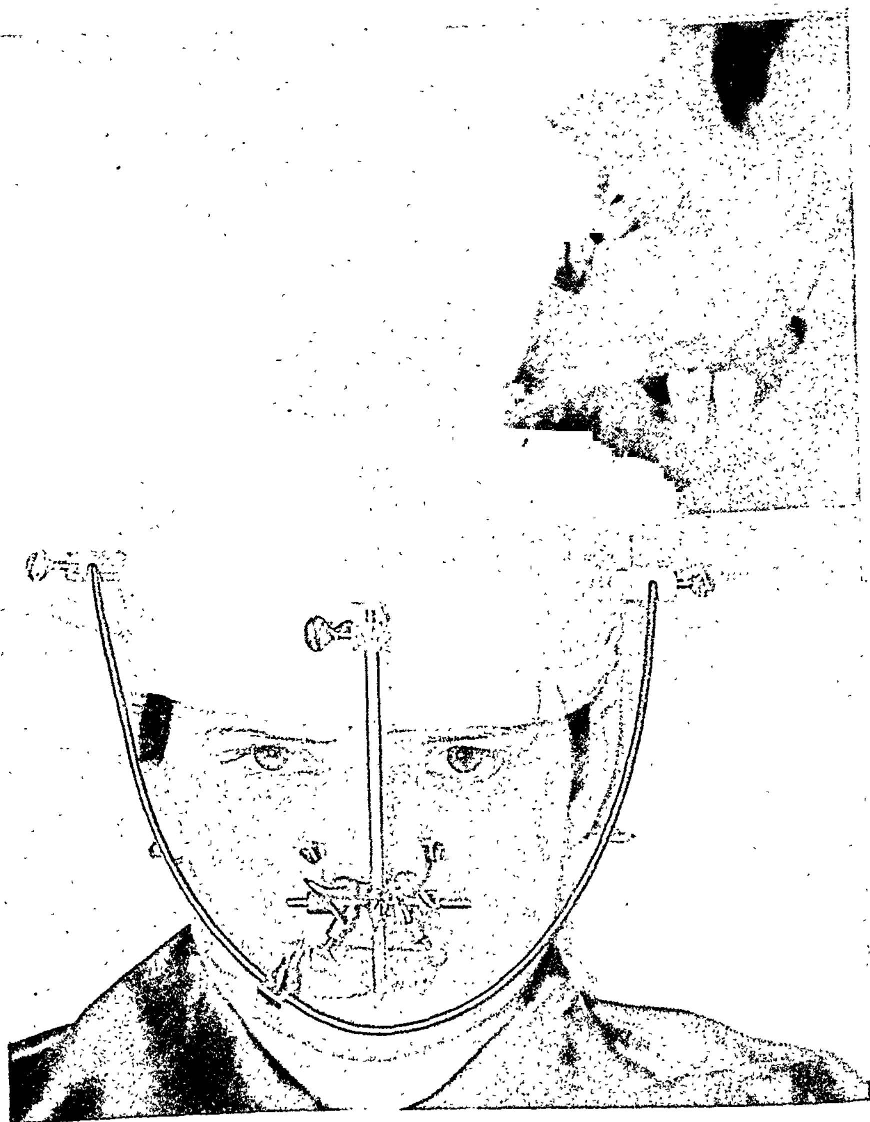


Fig. 66.—The rubber band mentioned in the text, on page 169, protrudes from the right corner of the mouth.

COMMENTS (*Continued*)

fracture under consideration requires, first, application to the upper dental arch of a hooked arch bar which is wired securely to each upper tooth (fig. 65). Next, a similar arch bar is wired to the teeth of the lower jaw. Then rubber bands stretched between the hooks of the upper and lower arch bars gradually pull the teeth into occlusion and, in turn, the upper jaw into proper alinement. If the maxilla is displaced backward, direct anterior traction becomes necessary in order to effect complete reduction of the fracture (fig. 65). This can be accomplished by stretching a rubber band from the upper arch bar to a rod attached to a plaster head cast. Such traction with rubber bands will give sufficient pull in a forward direction to bring the jaw into the desired position. In many cases of transverse maxillary fracture, the upper jaw is displaced upward and backward to a marked degree and very often the loose fragment is impacted in this position. (See insert of fig. 66 and fig. 67). Under such circumstances, strong downward traction is required to bring the teeth into occlusion. Here, a strong rubber band stretched from the upper arch bar to a curved rod, which passes downward anteriorly to the chin from the head cast, will give the desired downward pull on the upper jaw (fig. 66 and 67). When the maxilla is displaced downward, its upward elevation can be accomplished by the use of traction wires inserted through the cheeks. This phase of reduction of these fractures will be considered later.

After reduction of the fractured upper jaw and restoration of normal dental occlusion, some form of immobilization becomes necessary to maintain the maxilla in proper position until healing has occurred. For fixation, we have tried many of the methods which have been advocated in the literature, such as modifications of the Kingsley splint and various forms of fixation in which a dental face bow is employed. However, we have come to the conclusion that we can obtain the most satisfactory results by use of traction wires inserted through the cheeks as was first described by Federspiel. Not only do these traction wires offer perfect immobilization for the upper jaw but also they can be employed advantageously to produce the necessary upward trac-



Fig. 67.—Text on page 169.

COMMENTS (*Continued*)

tion on a maxilla which is displaced downward; when upward traction is required, no method seems to produce the desired results as well as traction wires. Without exception, we have been able to obtain strong union of the fragments by means of traction wires; such was not always the case when other methods of fixation were employed.

In the application of such traction wires (fig. 68), we employ two double strands of 26-gauge bronze or stainless steel wire. Each strand is attached to the upper arch bar in the bicuspid region, is passed directly through the cheek, and is fixed to a plaster head cast above. These traction wires permit direct upward pull on the upper jaw. They offer a form of immobilization which can be maintained for an indefinite period and which leads to strong bony union of the maxillary fracture. When one employs traction wires which are attached to a fixed post on the head cast (fig. 69) there is a strong probability of producing in each cheek a linear scar, which may become retracted to form a dimple.

The explanation of such scarring is that a straight line between the upper arch bar and the fixed post on the head cap passes through the skin of the cheek at a very definite point. Since it is impossible for one to determine the exact position of this point, before the traction wire has been inserted through the cheek, it usually emerges several millimeters away from the desired point. Consequently, when the wire is made tense, it pushes the soft tissues aside and the subsequent inflammatory reaction allows the wire to cut through the skin to produce a linear scar.

It is this scarring of the cheeks which has caused so many surgeons to disapprove strongly of the use of traction wires as a method of immobilization. However, scarring of the cheeks can be prevented almost entirely by use of adjustable hooks attached to the head cast (fig. 68). We have developed and employed two hooks which slide from side to side on a curved rod fixed to three metal posts that are incorporated in the plaster head cap. These hooks also can be made to swing anteriorly or



Fig. 68.—Text on pages 169, 171 and 173.

COMMENTS (*Continued*)

posteriorly as desired. Through this range of movement, the hooks can be adjusted so as to engage the traction wires in any axis which they have when they emerge from the cheeks. This prevents any lateral pressure of the traction wires on the soft tissues and, in turn, any tendency on these wires to cut through the cheek.

Traction wires through the cheeks do not cause the patient discomfort and, providing that bronze or stainless steel wire is employed, the wires will not irritate the tissue. One of our objections to Kingsley's splint and face bow appliances is that they tend to cause irritation and sometimes ulceration of the lips, particularly when they are maintained in position over a long period.

The efficiency of traction wires can be materially increased by attaching a small turnbuckle to each adjustable hook (fig. 68). The purpose of turnbuckles is twofold: First, should the head cap tip forward a trifle, a simple adjustment of the turnbuckles will readily take up the resultant slack in the traction wires. However, of more importance is the value of turnbuckles in cases of pyramidal and transverse facial fracture in which the maxilla is displaced slightly downward. Here, by giving the turnbuckles a few rotary movements on two or three successive days, the loose segment of bone, including the upper jaw, can be gradually elevated to correct position. However, if the downward displacement is marked, the upward pull produced by turnbuckles is not adequate and must be supplemented or supplanted by traction with rubber bands stretched from the adjustable hooks to the turnbuckles which have been removed from the former.

We would like to consider briefly the use of plaster head casts, which many surgeons have discarded for some form of adjustable headgear that can be transferred from one patient to another. With such appliances, they are able to obtain good results. However, in our practice at the clinic, plaster head casts have been more satisfactory since they are more stable when used over a long period. Moreover, a plaster head cast offers the only desirable means of attachment for the various appliances which we employ in the treatment of fractured facial bones. The construction of a plaster head cast is described in chapter X. In the



Fig. 69.—Text on page 171.

COMMENTS (*Continued*)

posteriorly as desired. Through this range of movement, the hooks can be adjusted so as to engage the traction wires in any axis which they have when they emerge from the cheeks. This prevents any lateral pressure of the traction wires on the soft tissues and, in turn, any tendency on these wires to cut through the cheek.

Traction wires through the cheeks do not cause the patient discomfort and, providing that bronze or stainless steel wire is employed, the wires will not irritate the tissue. One of our objections to Kingsley's splint and face bow appliances is that they tend to cause irritation and sometimes ulceration of the lips, particularly when they are maintained in position over a long period.

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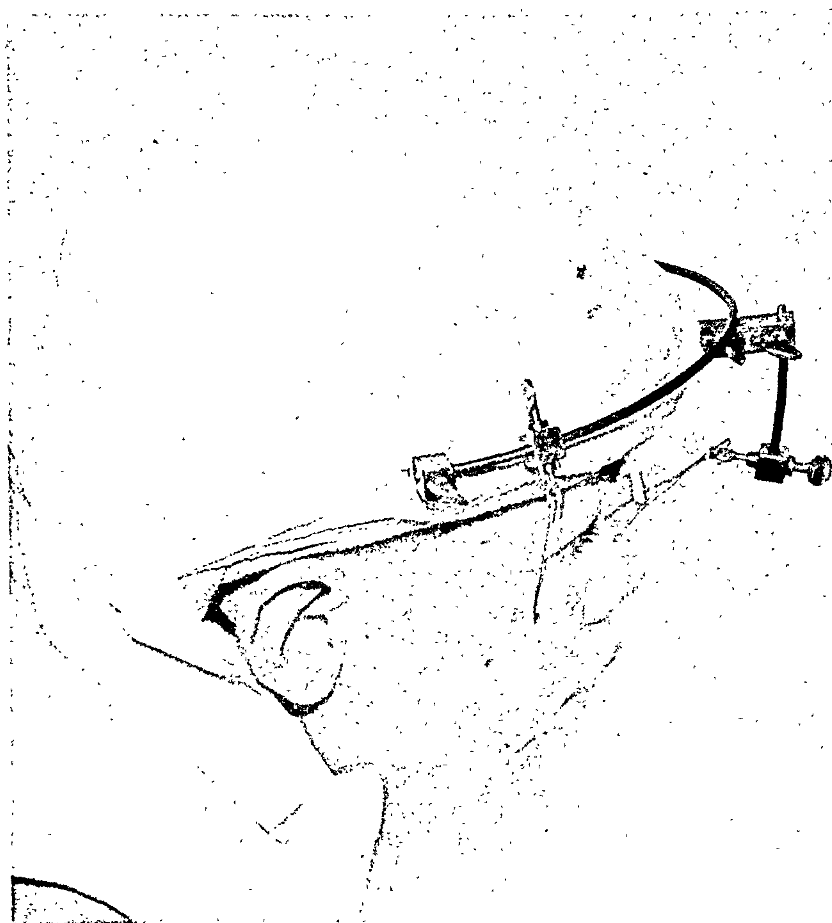


Fig. 70.—Text on page 175.

COMMENTS (*Continued*)

head cap is incorporated a metal band from which protrude three posts (fig. 65), which we have devised; to one or more of these three posts all of our appliances can be attached.

We have found it desirable to relieve the pressure of the head cap anteriorly when traction wires are employed because the latter tend to tip the plaster cast downward, with the result that an undue amount of pressure is applied to the forehead. In order to relieve this, we usually apply a strip of felt ¼ inch (0.64 cm.) thick to the forehead before the stockinet is applied. After the head cast has been completed, this piece of felt is removed, a space remaining between the cap and the skin of the forehead. By this procedure, any pressure sores or necrosis in the region of the forehead is obviated.

Before dismissing the subject of plaster head caps, we would like to stress the fact that they are much more satisfactory in the treatment of fractured facial bones of children than any form of adjustable headgear. However, if the patient is a child, it is well to carry the plaster down over the neck and shoulders; this hinders any attempt on the part of the patient to remove or displace the head cast (fig. 70).

Details of treatment are considered on pages 176 to 183 inclusive.

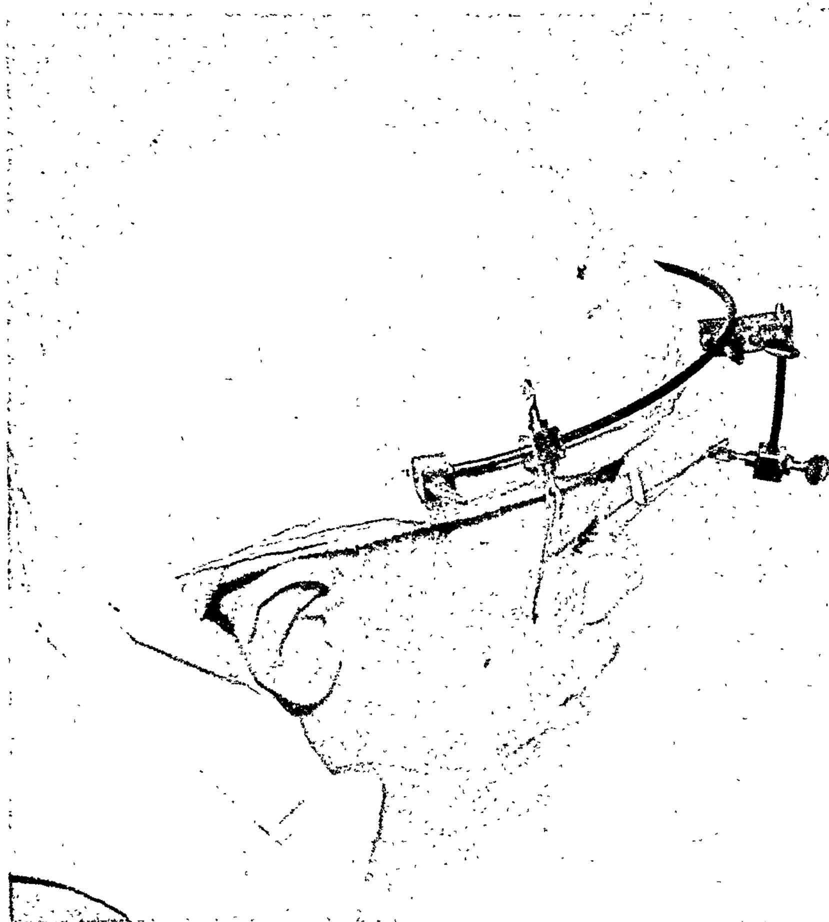


Fig. 70.—Text on page 175.

TREATMENT OF HORIZONTAL MAXILLARY FRACTURES BY INTERMAXILLARY ELASTIC TRACTION AND TRACTION WIRES (FIG. 71)

Immediate Care of the Patient.—As soon as symptoms of shock have been controlled, roentgenograms should be taken to make certain that there is not an associated pyramidal facial fracture or a fractured ethmoid bone. Should such be the case, treat the patient for a pyramidal fracture. See page 179.

Management of the Fracture.—Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a hooked arch bar to the teeth of the lower arch.

Stretch rubber bands between hooks of the upper and lower arch bars (see page 527 for details). If the maxilla is displaced backward, stretch a rubber band from the upper arch bar to a rod attached to the plaster head cast (fig. 65). If the maxilla is displaced upward, stretch a rubber band from the upper arch bar to a curved rod attached to the head cast (fig. 67). This arrangement of rubber bands produces the necessary traction to reduce the fracture and draw the teeth into proper occlusion.

Construct a plaster head cast in which is incorporated the metal band with posts for attachment of appliances. See pages 479 to 499 for details.

Insert traction wires through the cheeks. See pages 536 to 539. Attach the lower ends of these wires to the upper arch bar on each side between the second bicuspid and first molar tooth. Attach the upper ends of these wires to the turnbuckles on the adjustable hooks (fig. 71). Adjust tension of the traction wires so as to give adequate fixation of the upper jaw.

(Note: If, in a case of horizontal fracture of the upper jaw, the maxilla is displaced upward, then a face bow appliance for immobilization may be used satisfactorily after the teeth have been brought into proper occlusion. The insert in figure 71 illustrates one effective face bow appliance in use. However, if the maxilla is displaced downward, this appliance does not offer the necessary upward traction required in reduction and immobilization of the fracture; under these circumstances, traction wires are to be recommended.)

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

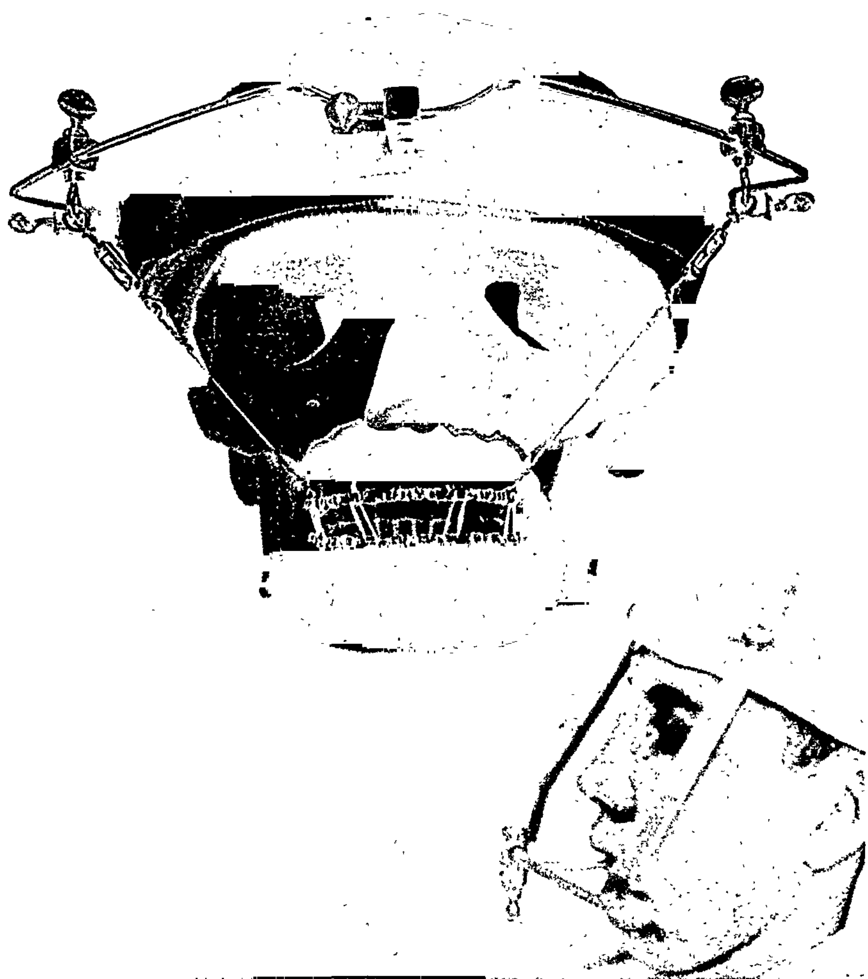


Fig. 71.—The face bow appliance represented in the inset was devised by Commander R. W. Taylor, (D.C.) U.S.N. Text on page 177.

TREATMENT OF PYRAMIDAL FACIAL FRACTURE BY INTERMAXILLARY ELASTIC TRACTION AND TRACTION WIRES (FIG. 72)

Immediate Care of Patient.—As soon as symptoms of shock have been controlled, examine the patient's nose for possible drainage of cerebrospinal fluid, indicating associated fracture of the ethmoid bone. Obtain roentgenograms. If there is no ethmoidal fracture, the surgeon may proceed with the treatment of the fractured maxilla at any convenient time. If a fractured ethmoid bone is present, treatment of the facial bones should be deferred for two weeks during which time one of the sulfa drugs should be administered as an aid in preventing meningitis. Wounds of soft tissue can be treated under local anesthesia as soon as the patient's general condition will permit.

Management of the Fracture.—Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a hooked arch bar to the teeth of the lower arch.

Construct a plaster head cast in which is incorporated the metal band with posts for appliances. See pages 479 to 499.

Stretch rubber bands between hooks of the upper and lower arch bars (see page 527 for details). If the maxilla is displaced backward, a rubber band should be stretched from the upper arch bar to a rod attached to the plaster head cast (fig. 65). This arrangement of rubber bands produces the necessary traction to reduce the fracture and proper occlusion.

Insert traction wires through the cheeks. See pages 536 to 539. Attach the lower end of these wires to the upper arch bar on either side, between the second bicuspid and first molar tooth. Attach the upper ends of these wires to the turnbuckles on the adjustable hooks (fig. 72).

If the maxilla is displaced only slightly downward, give the turnbuckles a few rotary movements on two or three successive days to elevate the upper jaw into proper position. If the maxilla is displaced markedly downward, remove the turnbuckles from the adjustable hooks and stretch strong rubber bands between these two devices; these rubber bands produce a great amount of upward traction, sufficient to elevate the maxilla.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 72.—Text on page 179.

TREATMENT OF PYRAMIDAL FACIAL FRACTURE BY INTER-MAXILLARY ELASTIC TRACTION AND TRACTION WIRES (FIG. 72)

Immediate Care of Patient.—As soon as symptoms of shock have been controlled, examine the patient's nose for possible drainage of cerebrospinal fluid, indicating associated fracture of the ethmoid bone. Obtain roentgenograms. If there is no ethmoidal fracture, the surgeon may proceed with the treatment of the fractured maxilla at any convenient time. If a fractured ethmoid bone is present, treatment of the facial bones should be deferred for two weeks during which time one of the sulfa drugs should be administered as an aid in preventing meningitis. Wounds of soft tissue can be treated under local anesthesia as soon as the patient's general condition will permit.

Management of the Fracture.—Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a hooked arch bar to the teeth of the lower arch.

Construct a plaster head cast in which is incorporated the metal band with posts for appliances. See pages 479 to 499.

Stretch rubber bands between hooks of the upper and lower arch bars (see page 527 for details). If the maxma is displaced backward, a rubber band should be stretched from the upper arch bar to a rod attached to the plaster head cast (fig. 65). This arrangement of rubber bands produces the necessary traction to reduce the fracture and proper occlusion.

Insert traction wires through the cheeks. See pages 536 to 539. Attach the lower end of these wires to the upper arch bar on either side, between the second bicuspid and first molar tooth. Attach the upper ends of these wires to the turnbuckles on the adjustable hooks (fig. 72).

If the maxilla is displaced only slightly downward, give the turnbuckles a few rotary movements on two or three successive days to elevate the upper jaw into proper position. If the maxilla is displaced markedly downward, remove the turnbuckles from the adjustable hooks and stretch strong rubber bands between these two devices; these rubber bands produce a great amount of upward traction, sufficient to elevate the maxilla.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

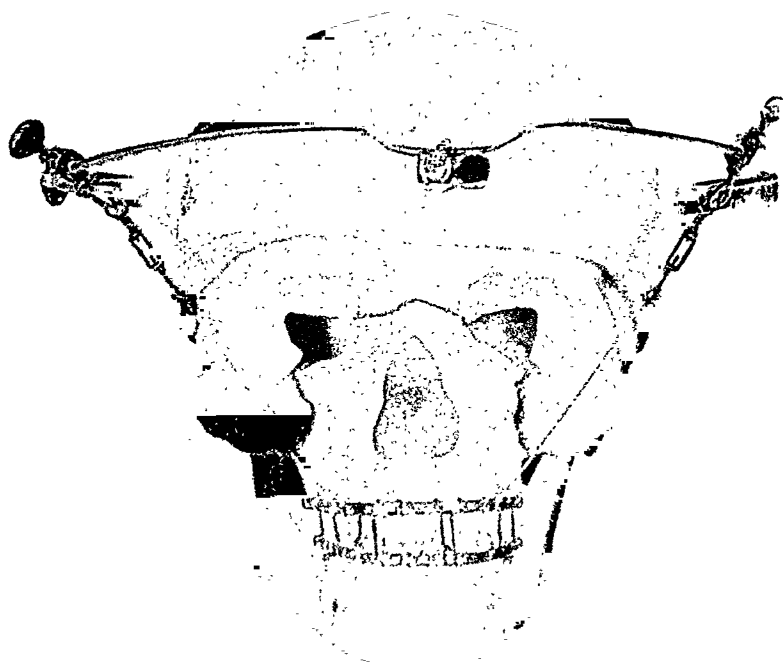


Fig. 72.—Text on page 179.

TREATMENT OF TRANSVERSE FACIAL FRACTURES BY INTERMAXILLARY ELASTIC TRACTION AND TRACTION WIRES (FIG. 73)

Immediate Care of the Patient.—Same as that described on page 179.

Management of the Fracture.—Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a hooked arch bar to the teeth of the lower arch.

Stretch rubber bands between hooks of the upper and lower arch bars (see page 527 for details). If the maxilla is displaced backward, a rubber band should be stretched from the upper arch bar to a rod attached to the plaster head cast (fig. 65). This arrangement of rubber bands produces the necessary traction to reduce the fracture and draw the teeth into proper occlusion.

Construct a plaster head cast in which is incorporated the metal band with posts for attachment of appliances. See pages 479 to 499 for details.

Insert traction wires through the cheeks. See pages 536 to 539. Attach the lower ends of these wires to the upper arch bar on either side between the second bicuspid and first molar tooth. Attach the upper end of these wires to the turnbuckles on the adjustable hooks (fig. 73).

If the maxilla is displaced only slightly downward, give the turnbuckles a few rotary movements on two or three successive days to elevate the upper jaw into proper position. If the maxilla is displaced markedly downward, remove the turnbuckles from the adjustable hooks and stretch strong rubber bands between these two devices; these rubber bands produce a great amount of upward traction, sufficient to elevate the maxilla up into proper position.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 73. Text on page 181.

TREATMENT OF FRACTURES WHICH PRODUCE COMPLETE SEPARATION OF AN EDENTULOUS UPPER JAW FROM THE REST OF THE SKULL (FIG. 74)

Immediate Care of the Patient.—Same as that described on page 179.

Management of the Fracture.—Fractures of the facial bones, with complete separation of an edentulous upper jaw, at times offer considerable difficulty in reduction. It is not always possible to reduce such fractures completely, but this is usually of little consequence provided the upper jaw can be thoroughly stabilized to bring about good bony union of the line of fracture. It has been our experience in such cases that traction wires which are attached to the upper denture or to an acrylic splint satisfactorily immobilize the maxilla and aid in securing the desired bony union (fig. 74).

Insert traction wires through the cheeks. See pages 536 to 539. Attach the lower ends of these wires to the patient's upper denture or to an acrylic splint made from a dental compound impression of the upper alveolar ridge. Attach the upper ends of these wires to the turnbuckles on the adjustable hooks. Adjust the tension of the traction wires so as adequately to immobilize the upper jaw.

Maintain fixation for about three weeks.

Feed the patient a soft diet.

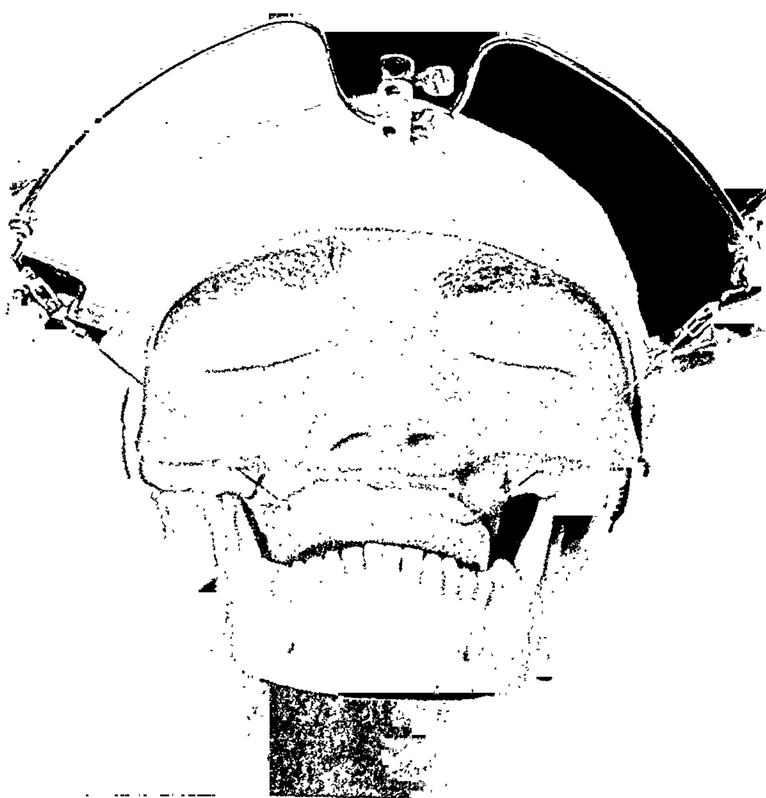


Fig. 74. Text on page 183.

Median Line Fracture of the Palate Associated with Horizontal Fracture of the Upper Jaw (Figs. 75 and 76)

COMMENTS

When a horizontal fracture of the maxilla is associated with a fracture in the median line of the palate, it is necessary that the two lateral fragments of the palate and alveolar process be brought into correct apposition before the upper teeth are returned to normal occlusion with the lower dental arch. The next requirement is immobilization.

Treatment is discussed on page 187.



Fig. 75.—Text on pages 185 and 187.

TREATMENT BY ELASTIC TRACTION AND TRACTION WIRES FOR IMMOBILIZATION (FIGS. 75 and 76)

Immediate Care of Patient.—Shock should be controlled before any manipulation of fragments of the upper jaw is undertaken.

Management of the Fracture.—Wire a hooked arch bar to the teeth in the lower dental arch and apply a segment of an arch bar to the teeth in each half of the upper jaw (fig. 75). See page 527 for details. The arch bar must not cross the line of fracture.

On each side, a hook is attached to the upper arch bar so as to emerge lingually in the interproximal space between the second bicuspid and first molar teeth (fig. 75).

Stretch a rubber band between these two hooks to bring the two halves of the palate and upper alveolar process into proper approximation.

Stretch rubber bands between the hooks of the upper and lower arch bars; such elastic traction gradually draws the teeth into proper occlusion and complete reduction of the fracture. (fig. 76).

After the teeth have been brought into occlusion, the intermaxillary rubber bands should be removed long enough to take out of the mouth the two hooks in the region of the palate and the rubber band between them. These hooks and this rubber band should be removed at this stage because, if they are left in position too long they produce considerable irritation of the tongue. Following their removal the intermaxillary rubber bands are reapplied.

Insert traction wires through the cheeks. See pages 536 to 539. Attach the lower ends of these wires to the lower arch bar somewhere in the second bicuspid region on each side. Attach the upper ends of these wires to the turnbuckles on the adjustable hooks (fig. 76). Adjust the tension of the traction wires so as to immobilize the lower jaw and, at the same time, elevate and fix the fragments of the upper jaw in proper relationship to the rest of the skull.

Maintain fixation for three to four weeks.

Feed the patient a liquid diet through a straw or glass tube.

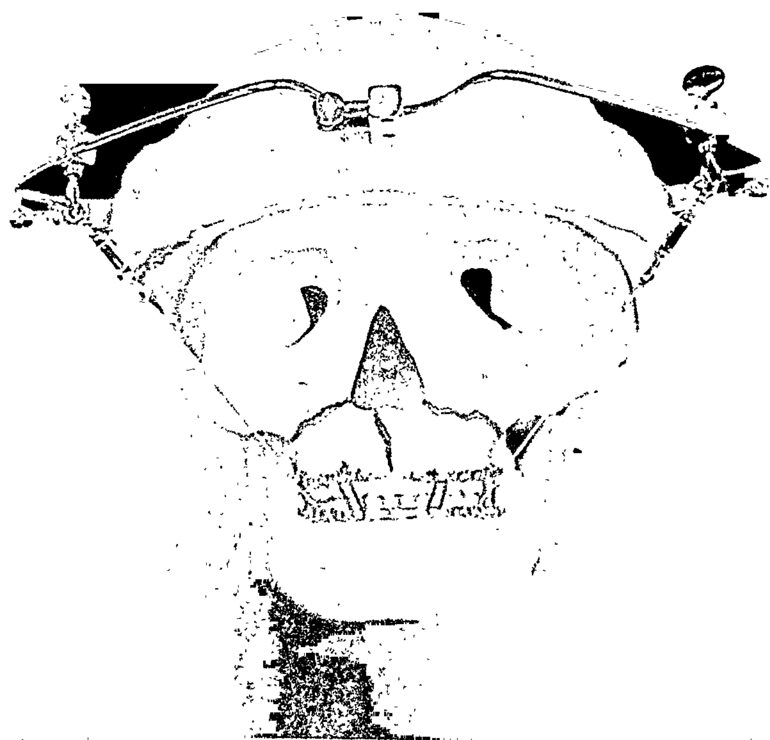


Fig. 76 Text on page 187.

Multiple Fractures of the Palate Associated with Horizontal Fracture of the Upper Jaw (Figs. 77 and 78)

COMMENTS

The treatment of multiple fractures of the palate associated with horizontal fracture of the upper jaw is much the same as that described in the previous problem. It is necessary, first, to bring the teeth into proper occlusion. Since a full upper arch bar cannot be applied because it would cross the lines of fracture, there is nothing on the upper jaw to which traction wires can be applied for immobilization. Under these circumstances, the traction wires must be applied to the lower arch bar; this procedure fixes the mandible and, in turn, the fragments of the upper jaw are immobilized.

Details of treatment are considered on page 191.

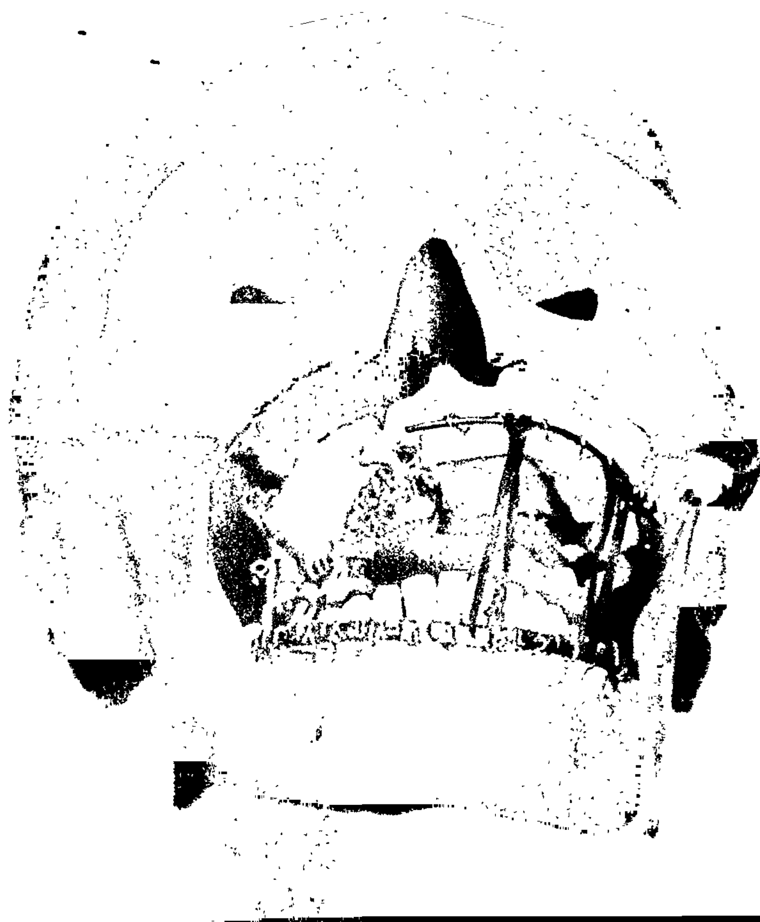


Fig. 77. Text on pages 189 and 191.

TREATMENT BY ELASTIC TRACTION AND TRACTION WIRES FOR IMMOBILIZATION (FIGS. 77 and 78)

Immediate Care of Patient.—Shock should be controlled before any manipulation of fragments of the upper jaw is undertaken.

Management of the Fracture.—Wire a hooked arch bar to the teeth in the lower dental arch.

For the disposition of a fragment of the upper jaw in which there is but a single tooth, attach an anchor clamp band having a buccal sheath to the tooth. The sheath serves as an excellent attachment for intermaxillary rubber bands and such a band, when securely attached, cannot be displaced (fig. 77).

If there are several teeth in a fragment, it is preferable to employ a portion of an arch bar, wiring it to each tooth in the fragment (fig. 77).

Stretch rubber bands between the upper and lower arch bars and between the lower arch bar and the sheaths of the upper anchor clamp bands; such elastic traction gradually draws the teeth into proper occlusion (figs. 77 and 78).

Insert traction wires through the cheeks. See pages 536 to 539. Attach the lower ends of these wires to the lower arch bar somewhere in the region of the second bicuspid on each side. Attach the upper ends of these wires to the turnbuckles on the adjustable hooks (fig. 76). Adjust the tension of the traction wires so as to immobilize the lower jaw and at the same time elevate and fix the fragments of the upper jaw in proper relationship to the rest of the skull.

Maintain fixation for three to four weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 78. Text on page 191.

Unilateral Fractures of the Upper Jaw (Figs. 79 to 84 Inclusive)

COMMENTS

Usually, a unilateral fracture of the upper jaw is the result of a blow directed from the side and, consequently, the loose fragment of bone is displaced downward and inward. Moreover, such a fracture is commonly associated with a depressed fracture of the malar bone on the same side, and not infrequently with fracture of the mandible and loss of several lower teeth.

In many instances, there is but little displacement of the fragment of the upper jaw and, under these circumstances, treatment is very simple (fig. 79). However, in some cases, forceful reduction of the maxillary fracture is entirely unsatisfactory and special appliances become essential for proper reduction and immobilization. First, some form of appliance is required to hold the loose fragment of the upper jaw outward. Although such a device will push this fragment laterally, it will not correct the downward displacement of the fragment. When the patient attempts to close his mouth, the teeth of this fragment come in contact with the teeth of the lower jaw, but an open bite is left on the opposite side of the mouth. To overcome this open bite and simultaneously to force the loose fragment of bone upward into correct position, it is necessary to use intermaxillary elastic traction on the uninvolved side of the mouth. Closure of the open bite on the side of the mouth opposite the injury will, at the same time, force the loose fragment of the maxilla up into proper position.

Details of treatment are considered on pages 195 and 201.

Illustrations on pages 194, 196, 197, 198, 199 and 200.

TREATMENT OF A UNILATERAL FRACTURE OF THE UPPER JAW IN WHICH THERE IS LITTLE DISPLACEMENT (FIG. 79)

The fracture can be reduced manually, and immobilization can be obtained by some simple form of intermaxillary wiring; or immobilization can be obtained by a divided upper splint. Such a splint is constructed in the following manner:

1. Obtain hydrocolloidal (dentocol) impressions of the upper and lower dental arches.
2. Prepare plaster models from these impressions.
3. Cut the upper plaster model at the site of the fracture.
4. Mount the two upper plaster segments and the lower plaster model in proper relationship on a dental articulator.
5. Prepare a wax model for a divided splint as described on pages 565 to 567.
6. From this wax model, prepare a cast silver splint.

Manipulate the loose upper fragment into proper position, and apply the splint, wiring the two outer flanges together by passing a wire around the divided button anteriorly (fig. 79). No intermaxillary wires are necessary for immobilization when such a splint as this is employed.

Maintain fixation for about four weeks.

Feed the patient a soft diet.



Fig. 79.—This model shows the wax pattern for a cast, silver, divided splint. Text on page 195.

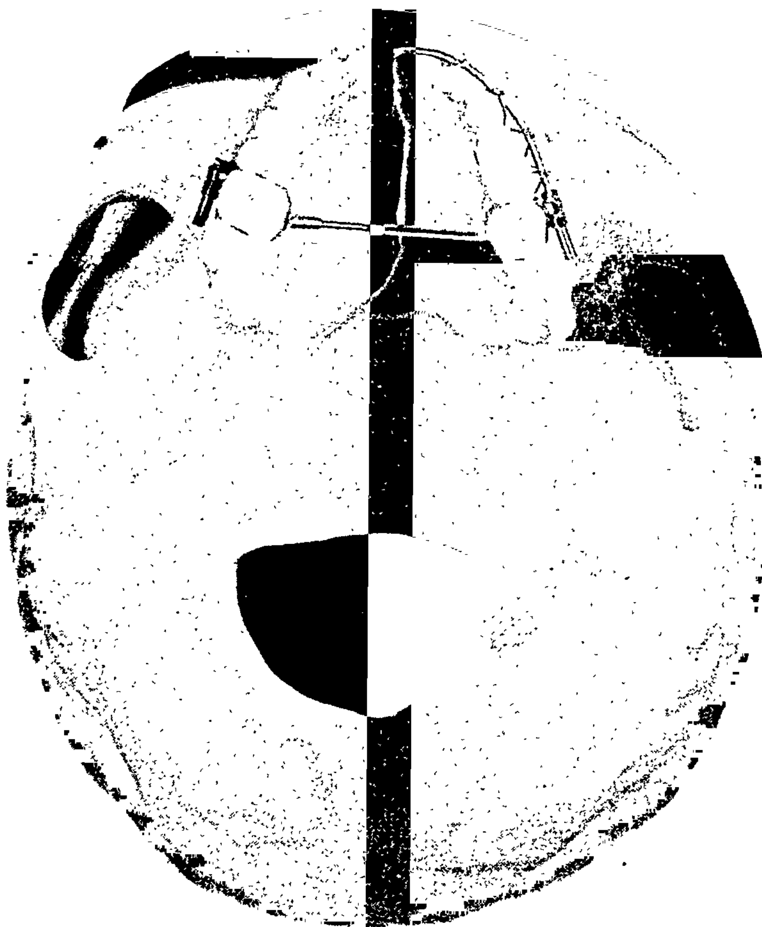


Fig. 81.—Text on page 201.

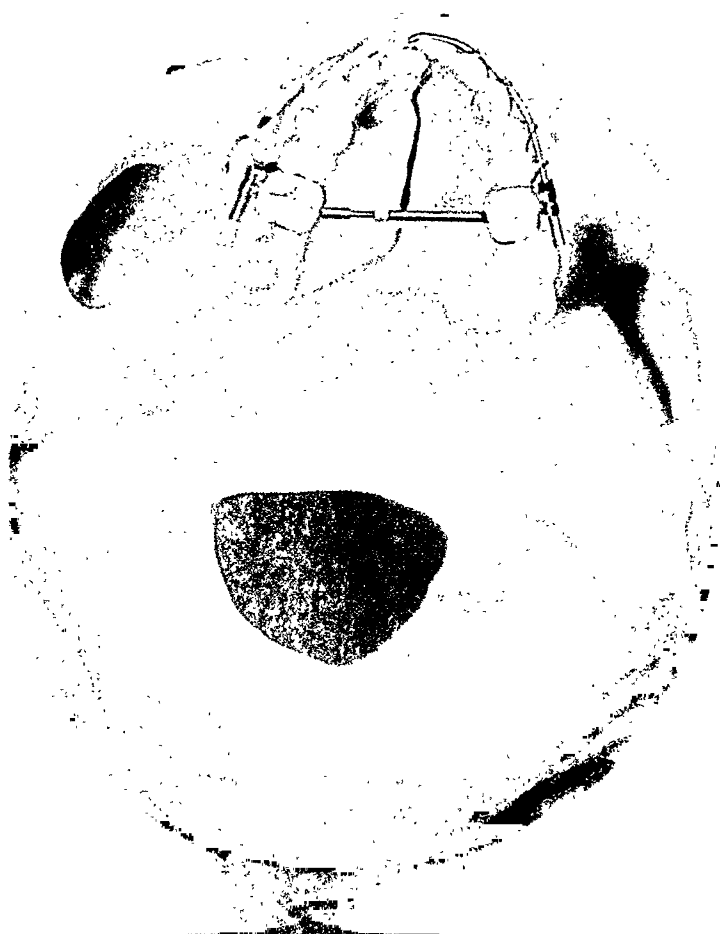


Fig. 80. Text on page 201.

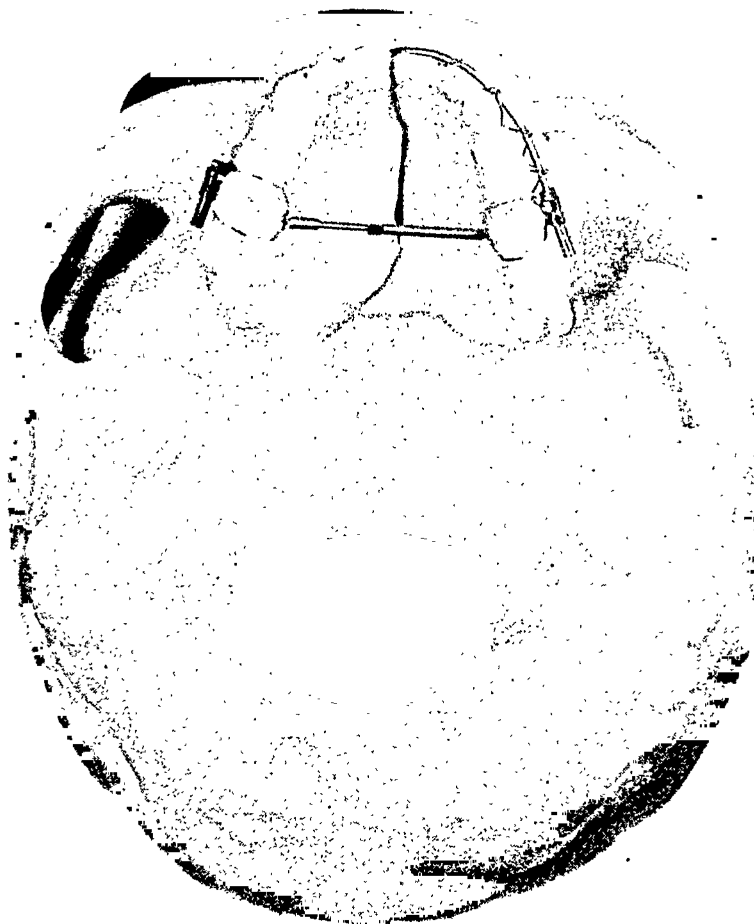


Fig. 81.—Text on page 201.



Fig. 82. Text on page 201.



Fig. 83.—Text on page 201.



Fig. 81. Text on page 201.

TREATMENT OF UNILATERAL FRACTURE OF THE UPPER JAW IN WHICH THERE IS CONSIDERABLE DISPLACEMENT OF THE LOOSE FRAGMENTS (FIGS. 80 to 84 Inclusive)

Some appliance is necessary to force the loose upper fragment laterally. We prefer to use a jackscrew for this purpose. One anchor clamp band having a buccal sheath is attached to the first molar tooth on each side of the upper jaw; a small pin for reception of the jackscrew should be soldered to the lingual surface of each band.

Insert a jackscrew between the two molar bands as is illustrated in figure 80. On turning the nut of the jackscrew, the loose upper fragment is forced outward until the contour of the upper dental arch is normal as is represented in figure 81. (Note: If a jackscrew is not available, the right upper fragment can be pulled laterally by elastic traction as is shown in figure 84. However, in our experience, the jackscrew is much more satisfactory.)

At this stage in the treatment, the fragment is forced laterally but still is displaced downward. When the patient attempts to close his mouth, the teeth of this fragment come in contact with the teeth of the lower jaw but an open bite results on the opposite side of the mouth. To overcome this open bite and to force the loose fragment upward into position, it is necessary to apply an arch bar to the uninjured half of the upper jaw and to wire a full arch bar to the teeth of the lower jaw (fig. 82).

Intermaxillary rubber bands are applied between the arch bars on the uninjured side of the mouth (fig. 82). This elastic traction closes the open bite on the uninjured side of the mouth and simultaneously forces the loose upper fragment of bone up into proper position (fig. 83).

After the loose upper fragment of bone has been returned to its proper position for one or two days, the intermaxillary rubber bands should be removed long enough to allow of removal of the jackscrew, which becomes very irritating to the dorsum of the tongue. Intermaxillary rubber bands are then reapplied and can be replaced by intermaxillary wires after the teeth are again in proper occlusion.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

Simple Fractures of the Upper Alveolar Process

COMMENTS AND TREATMENT

Occasionally fractures of the upper jaw occur in which the l
of fracture assumes a horizontal course and involves only
alveolar process. The treatment here is based entirely on
relationship of the line of fracture to the *roots of the teeth*
the fracture passes across the occlusal or incisal half of the den
roots, no treatment is required and the teeth may be retain
However, if the fracture line is situated close to the apices
the dental roots, as is illustrated in figure 60, there is danger
necrosis of the pulp of these teeth because their blood sup
has been cut off or disturbed. Under these circumstances,
involved teeth should be extracted and often it is better
remove the loose bone intervening between them as well.

CHAPTER IV

FRACTURES OF THE MALAR BONES

DISPLACED, fractured malar bones can be easily overlooked for a time after the injury because of the excessive swelling and ecchymosis of the overlying soft tissues. Such a fractured bone can be elevated readily at the time of the injury but, if neglected, conspicuous flattening of the cheek ensues, a deformity which never can be corrected completely by plastic methods. Consequently, we would like to stress the importance of careful examination for a possible fractured malar bone in every case in which injury to the cheek has been sustained.

The diagnosis of fractured malar bones is based on palpation and roentgenographic studies. Palpation of both infra-orbital rims is to be recommended for detection of asymmetry, because an irregularity, particularly over the infra-orbital foramen, is a common finding. However, dependence should not be placed solely on palpation for final diagnosis; too frequently this method of examination is unreliable, due to the swelling of the soft tissues. Consequently, roentgenograms are essential in all cases. In addition to direct anteroposterior views, we secure a "vertical profile" film (fig. 85), in which the rays are directed from the chin toward the vertex. Such a roentgenogram demonstrates well the relative position of the two inferior orbital margins and the degree of displacement if one or both malar bones are fractured and displaced. Because it is necessary to tilt the patient's head extremely far backward, with the chin pointed directly upward, in order to obtain a vertical profile roentgenogram of the facial bones, it occasionally is impossible to obtain this type of view if the patient has sustained serious injury to the neck or skull or if he is comatose. Under these circumstances, it is well to tilt the patient's head as far back as is conveniently possible to



Fig. 85.—Vertical profile view of normal skull. Text on page 203.

obtain a semivertical profile view, such as will be seen in figure 87.

Following the diagnosis of fractured malar bone, examination of the eyeball on the involved side should be made before instituting any form of treatment. Disturbances in ocular movements not infrequently are complications of fracture of the malar bones and should be discovered preoperatively rather than postoperatively. Such ocular disturbances are palsy of some of the extra-ocular muscles, alteration in level of the eyeball and enophthalmos. The most commonly occurring type of extra-ocular palsy involves the inferior oblique muscle and is due to injury of the orbital attachment of this muscle. Palsy of extra-ocular muscles also may result from intra-orbital hemorrhage or from downward displacement of the level of the eyeball when the floor of the orbit is crushed. Regardless of the cause of the palsy, the patient experiences diplopia. Involvement of the external rectus muscle can occur, due either to direct injury to the side of the orbit or, more commonly, to hemorrhage. However, it is surprising how uncommonly extra-ocular palsy is due to edema of the orbital tissues; this is also true of displacement of the eyeball. Downward displacement of the eyeball can result from simple, uncomminuted malar fracture but it is more often encountered, and is more serious, in the presence of comminuted fractures in which the upper surface of the malar bone, which also forms the floor of the orbit, is badly crushed (fig. 86). Enophthalmos may occur when the floor of the orbit is forced downward due to a malar fracture; such displacement enlarges the orbit and allows the orbital contents, including the globe, to drop backward. When due to this cause, enophthalmos is often corrected by reduction of the fracture. Enophthalmos may also rarely occur long after the injury, as a trophic disturbance in which the orbital fat becomes absorbed.

It is extremely important, before any treatment is attempted, that the movements and the level of the eyeball be thoroughly examined. Reduction of the fractures often will correct extra-ocular disturbances but in many instances they are permanent. Residual extra-ocular disturbances sometimes can be helped but never can be completely corrected by plastic or ophthalmologic

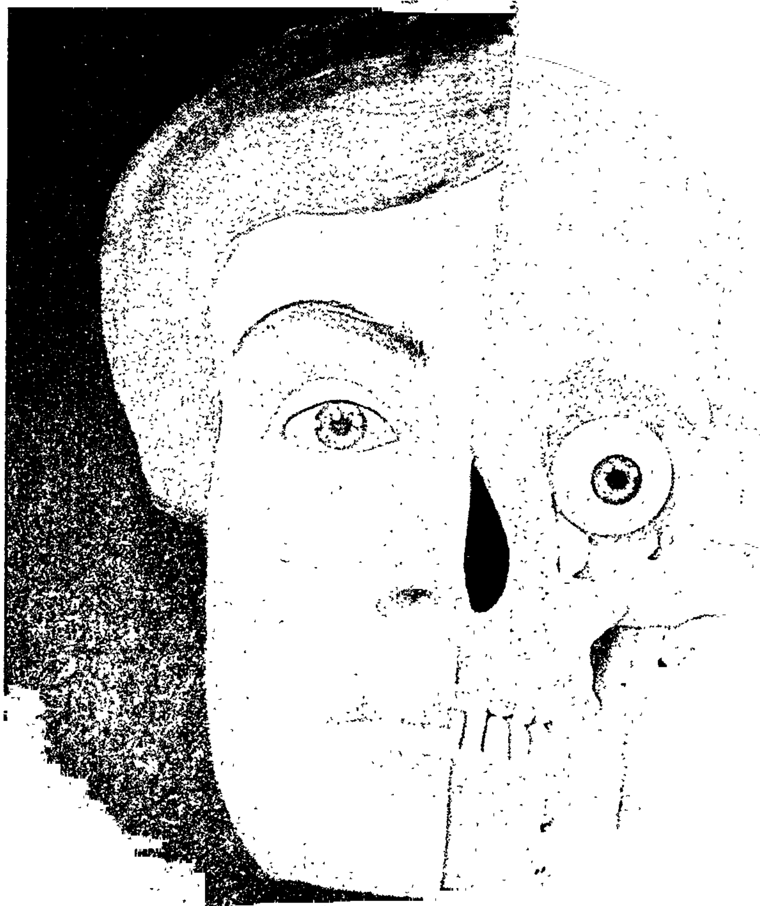


Fig. 86.—Text on page 205.

measures. However, for all such residual extra-ocular defects, the services of an ophthalmologist are highly desirable.

We have found it of advantage in the treatment of fractured malar bones to classify them in the following groups:

1. Recent uncomminuted fractures, with displacement.
2. Recent comminuted fractures.
3. Uncomminuted fractures sustained several days before treatment.
4. Old depressed fractured malar bones with external deformity.



Fig. 87.—Text on page 209.

Recent, Uncomminuted Fracture of Malar Bone, with Displacement (Figs. 87 to 91 Inclusive)

COMMENTS

Malar bones are often fractured so that they retain their continuity with little or no comminution. In these cases, the fractures occur along the normal suture lines, that is, through the frontozygomatic suture above, through the temporozygomatic suture laterally and through the inferior orbital foramen below. The bone is generally depressed downward and backward.

Many different instruments and methods of approach have been suggested for elevation of malar bones which have sustained simple fracture. Some surgeons prefer an external approach, either through small skin incisions in various locations on the cheek or through a skin incision in the temporal region; others advocate an intra-oral approach to the malar bone. It is our opinion that it really makes little difference what form of treatment is employed, providing the displaced bone is returned to its original position. In our practice we usually prefer to elevate the bone through a small skin incision through the cheek. For the actual elevation, we often employ a steel hook.

These simple fractures of a malar bone can be reduced readily within the first few days following the injury. However, after a week, elevation of one of these bones becomes increasingly more difficult until, with the passage of another week's time, it is practically impossible to return the malar bone to its original position by the above mentioned methods. Consequently, we would like to stress the importance of early elevation in cases of simple fracture of the malar bones whenever possible. Not infrequently, in the presence of associated injuries such as fracture of the ethmoid bone, it is necessary to defer treatment of the malar bones for two or more weeks. Under these circumstances, the malar bone must be treated as is described in problem 34.

An uncomminuted fracture of a malar bone is unlikely to result in occlusion of the normal opening of the antrum into the nose. Should such atresia develop, producing symptoms of antral obstruction, an intranasal window into the antrum can be made by an otolaryngologist at any time.

Treatment is considered on pages 210 to 213 inclusive.

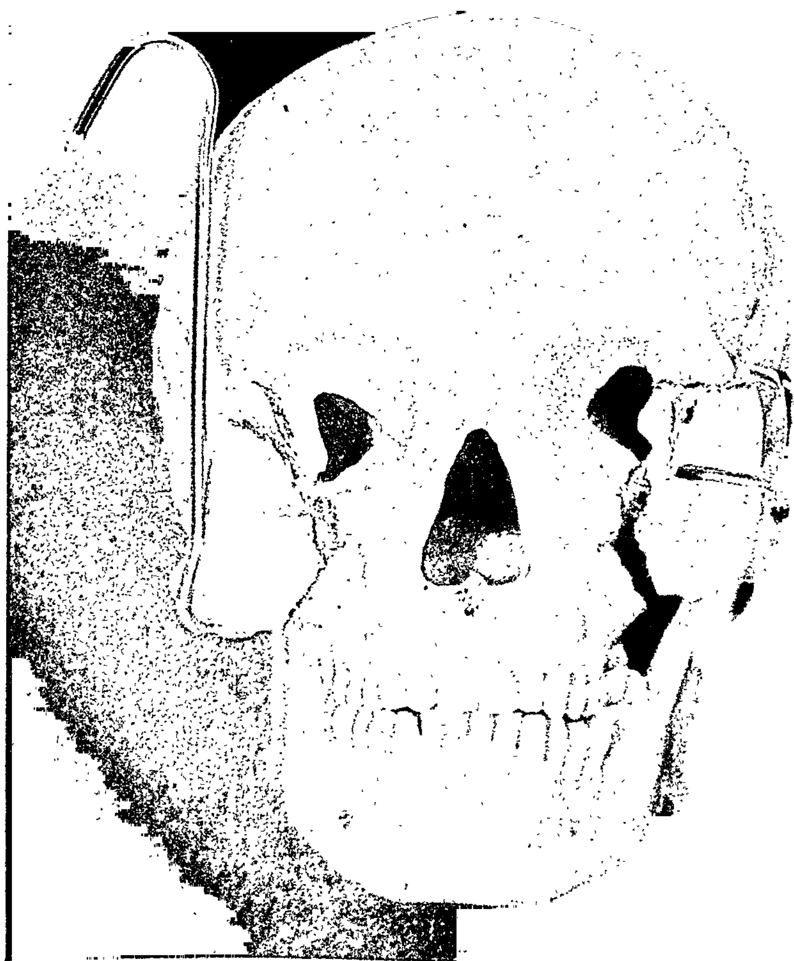


Fig. 88.—Text on page 213.

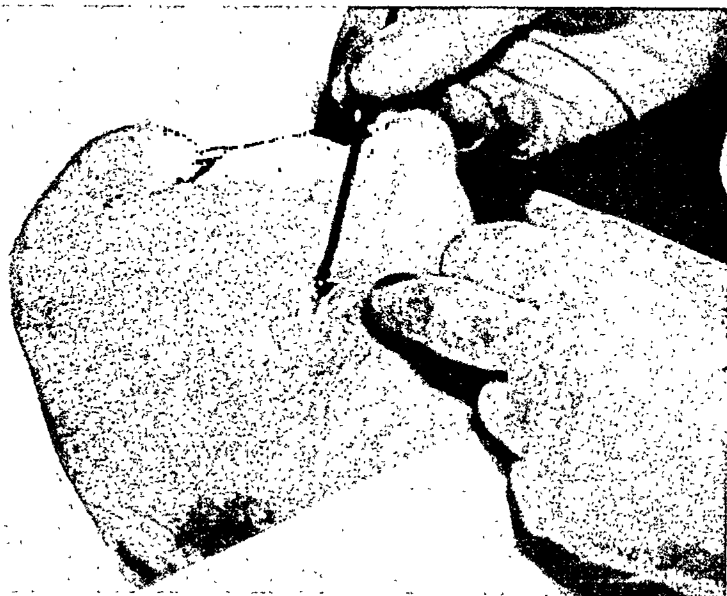


Fig. 89.—Insertion of a hook, through a small skin incision, along the floor of the orbit for elevation of a displaced, fractured malar bone. See figures 88 and 90.



Fig. 90.—See figures 88 and 89. With the hook which has been inserted along the floor of the orbit to engage the anterior margin of the inferior orbital fissure, traction is being made to pull the depressed malar bone forward. The hook enters the orbit through the incision represented in figure 89. It is only distortion due to traction which makes it appear that the hook is inserted between the lids.



Fig. 91.—Text on page 213.

TREATMENT OF RECENT UNCOMMINUTED FRACTURE OF MALAR BONE WITH DISPLACEMENT (FIGS. 88 to 91 Inclusive)

Secure anteroposterior and vertical profile roentgenograms.

Carefully examine the movements and the level of the involved eyeball.

If the malar bone is displaced essentially downward, we make a small skin incision along the lower border of the malar bone. Through this incision is thrust a steel hook, with which the inferior margin of the malar bone is grasped. On making forceful traction upward and forward, the bone is elevated into its normal position (fig. 88, right malar bone). No form of fixation is ordinarily required. We prefer this method of elevation because it seems to us that better leverage can be obtained to elevate the bone; the small skin incision is not objectionable because it practically disappears after a few weeks.

If the malar bone is displaced essentially backward, the hook can be passed along the floor of the orbit through a small skin incision so as to engage the anterior margin of the inferior orbital fissure. By this approach, a direct anterior force can be placed on the malar bone and this facilitates reduction of the fracture. After elevation, no method of fixation is required (figs. 88 [left malar bone], 89 and 90).

If the malar bone is displaced so that the zygomatic arch is rotated inward, it can be pulled outward with a hook inserted through a small incision in the skin along the lower border of the malar bone. If it is preferred, an incision in the skin of the temporal region offers another method of approach; through such an incision can be thrust a blunt elevator or forceps which is carried downward below the malar bone and which can be used for prying outward the displaced bone (fig. 91). Here again, no form of immobilization is required after reduction of the fragment.

Several days after reduction of the fracture, it is well again to determine the movements and level of the eyeball on the involved side.



Fig. 92.—Comminuted fracture of right malar bone. Text on page 215.

Recent Comminuted Fracture of Malar Bone (Figs. 92 to 99 Inclusive)

COMMENTS

When a malar bone is badly comminuted, it is useless to employ a hook or similar instrument for elevation of fragments. Instead, we recommend an operation by which the antral cavity is opened through an intra-oral incision; this permits elevation of the fragments from within the antrum.

Early treatment, that is, within four or five days after the injury, is not so important for a comminuted malar bone as it is in the case of an uncomminuted fractured zygoma. Even after two or three weeks, reduction of a comminuted malar fracture can be accomplished without difficulty by the above method of treatment.

In a case of badly comminuted fracture of the malar bone, especially when associated with comminution of the floor of the orbit, downward displacement of the eyeball is commonly encountered. Consequently, it is of great importance to examine preoperatively the movements and level of the eyeball on the involved side. Fortunately, these extra-ocular disturbances are frequently corrected by proper reduction of the fracture.

A comminuted fracture of the malar bone may produce occlusion of the normal opening of the antrum into the nose. However, we do not recommend constructing an antral window at the time of elevation of the fragments of the malar bone. At some later date, if atresia develops and produces symptoms of antral obstruction, then an intranasal antral window can be prepared by an otolaryngologist.

Treatment on pages 216 to 224 inclusive.



Fig. 93.—Incision being made in the upper bucco-alveolar fold, through which exposure of the antral cavity can be obtained. Next, an elevator is introduced through the incision to push the soft tissues away from the underlying bony structures. Access to the interior of the antrum is then possible. Text on page 223.

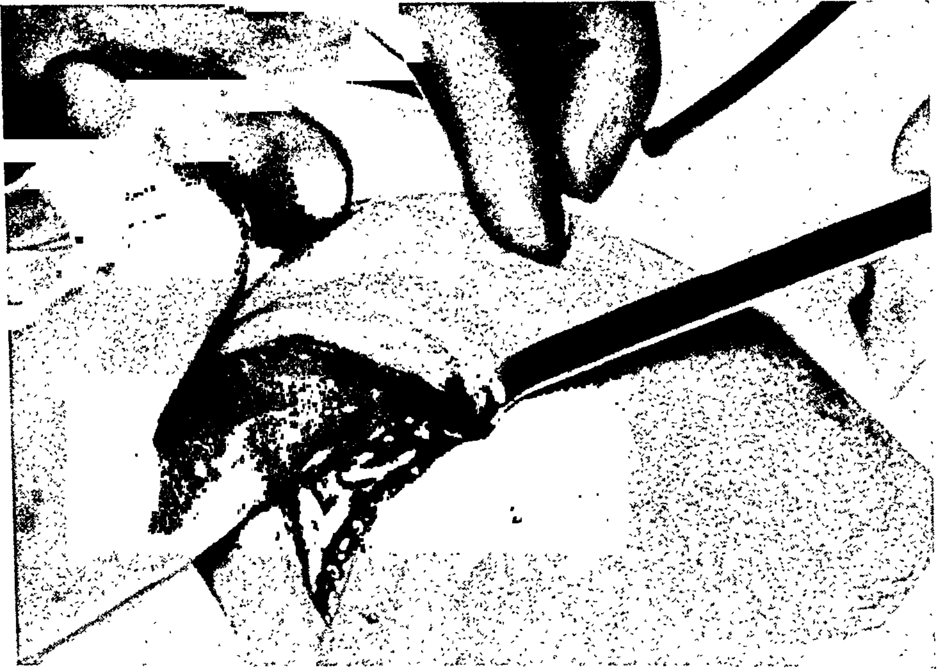


Fig. 94.—The index finger of one hand is inserted within the antral cavity and, with the other hand placed externally, the fragments of the comminuted malar bone can be manipulated into proper position. Text on page 223.

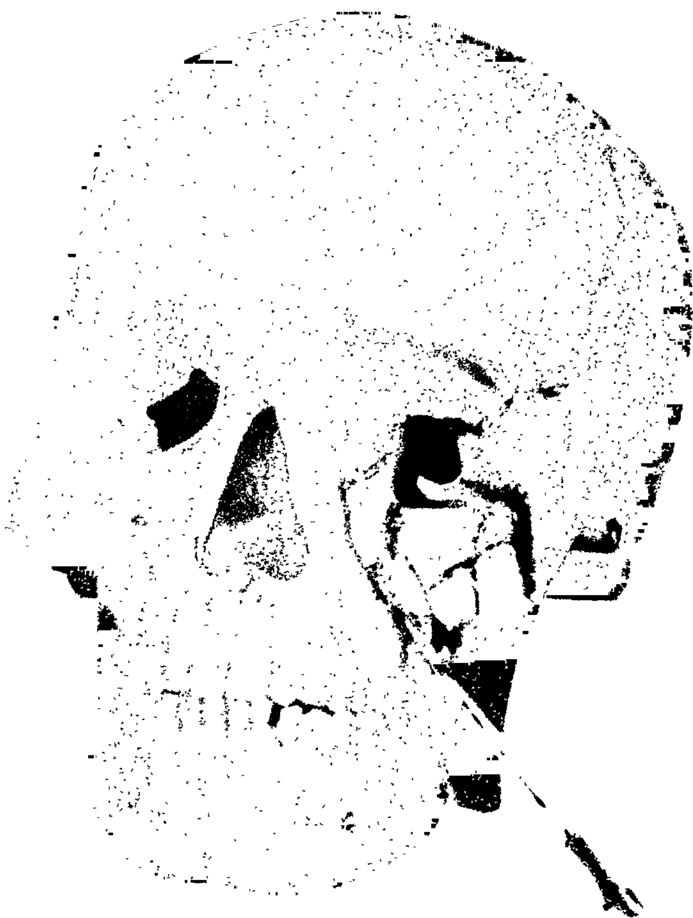


Fig. 95.—Exposure of antral cavity by an elevator inserted through an intra-oral incision. Text on page 223.



Fig. 96.—A Penrose drain and iodoform pack are being introduced into the antral cavity following elevation of the fragments of a comminuted malar bone. The drain permits escape of any purulent material which may develop in the antral cavity; the iodoform gauze, when packed tightly, immobilizes the fragments. Text on page 223.

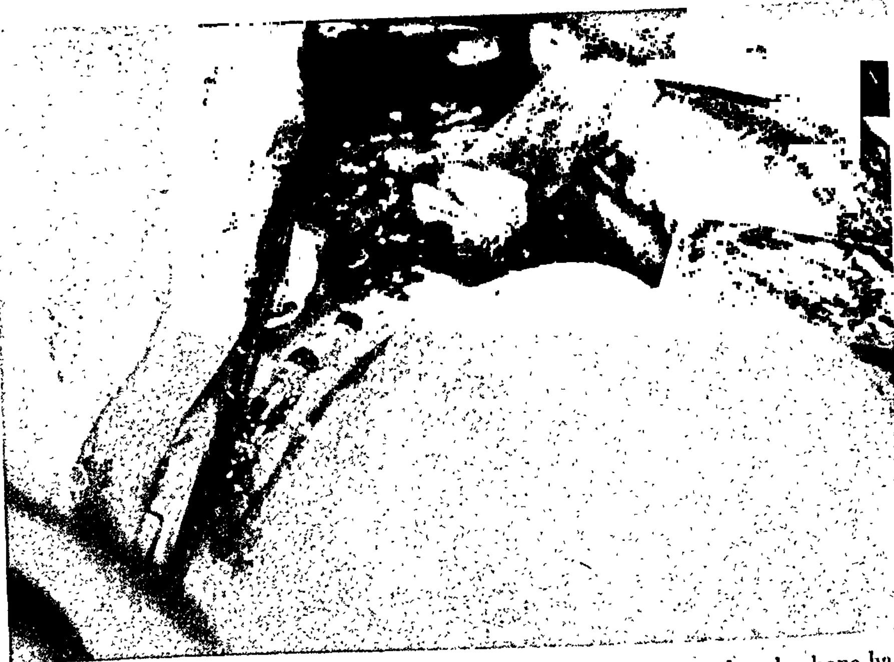


Fig. 97.—Operation for elevation of fragments of a comminuted malar bone has been completed; the iodoform pack for immobilization of the fragments is visible, as are the ends of the Penrose drain. Text on page 223.

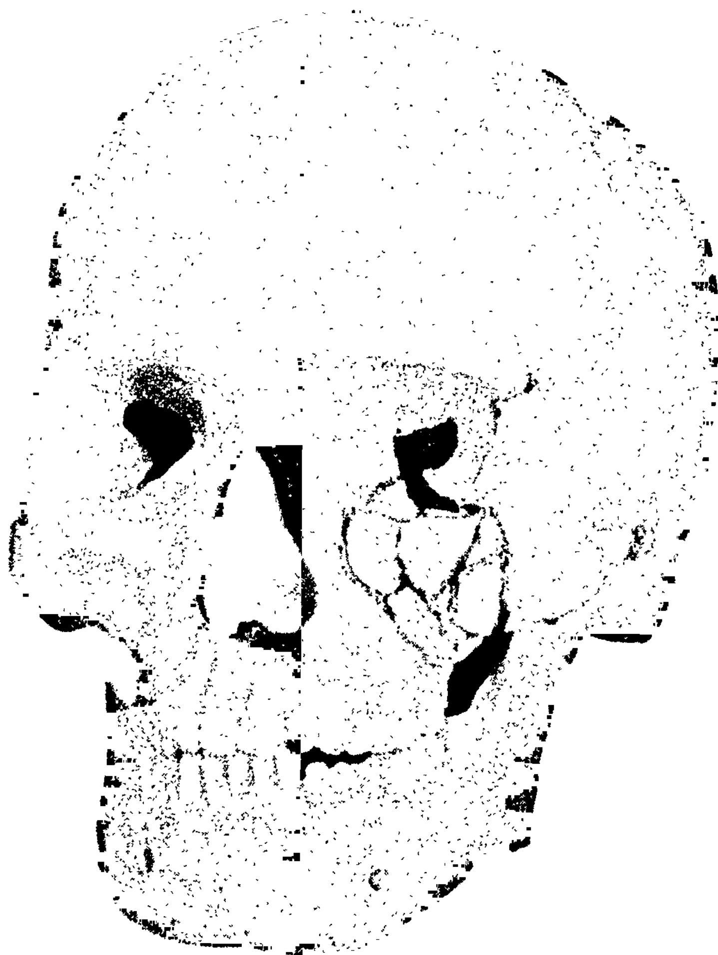


Fig. 98.—Immobilization of fragments of a comminuted malar bone by means of an iodoform pack. Text on page 223.



Fig. 99.—Edema of the eyelids following severe comminution of the left malar bone; edema is due to lymphatic obstruction and occasionally requires months or years to disappear. Text on page 224.

TREATMENT OF RECENT COMMINUTED FRACTURES OF THE MALAR BONE (FIGS. 93 to 99 Inclusive)

Secure anteroposterior and vertical profile roentgenograms of the malar bone. Carefully determine the movements and the level of the involved eyeball.

A comminuted malar bone necessitates elevation of the fragments from within the antrum. During such an operation there is considerable bleeding and it is well to use intratracheal gas and ether anesthesia. If this method of anesthesia is employed, the throat can be packed off so that bleeding is of no concern. Elevation of the fragments under local anesthesia is a painful procedure and is not to be recommended.

Make an incision through the upper bucco-alveolar fold within the mouth on the involved side (fig. 93).

By means of a blunt periosteal elevator or a large curet, push the soft tissues aside over the lower anterior portion of the maxilla and adjacent portion of the malar bone.

If the malar bone is badly comminuted, it usually is not difficult to gain entrance to the antral cavity. However, when the antral cavity is obliterated by a compression type of fracture, it sometimes is difficult to gain access to the interior of the antrum. If possible, the index finger of one hand should be inserted within the antral cavity and, with the other hand placed externally, the fragments of the fractured malar bone can be manipulated into proper position (fig. 94). If it is not possible to insert the index finger of one hand within the antral cavity, then it becomes necessary to use a blunt instrument for elevation of the fragments from within the antrum (fig. 95).

Insert a Penrose drain within the antrum in such a manner that the drain forms a loop with its two free ends protruding through the incision in the mucous membrane and into the mouth; this drain permits escape of any purulent material that forms within the antrum (figs. 96 and 97). Insert a tight iodoform pack within the antrum for immobilization of the fragments (figs. 96, 97 and 98).

The pack and drain should not be removed for three weeks. After this time sufficient fibrous tissue has formed around the fragments to maintain them in correct alinement.

In a case of severely comminuted fracture of the malar bone, particularly when associated with an extensive wound of the overlying soft tissues, many of the smaller fragments may be lost or may undergo sequestration. Under these circumstances, a great deal of scar tissue may develop in and around the malar bone, sufficient to interfere with proper lymphatic drainage. In consequence, edema of the eyelids on the involved side may occur and months or years may be required for the edema to disappear completely. No treatment is of any particular value in preventing or overcoming this edematous condition of the eyelids (fig. 99).

Several days after reduction of the fracture, it is well to determine again the movements and level of the eyeball on the involved side. If some disturbance of extra-ocular movements or level of the eyeball still persists after reduction of the comminuted fracture, plastic surgical procedures, attempted several months later, often will correct, or at least improve, such disturbances.

Problem 34 is taken up on the next page.



Fig. 100.—A blunt elevator is inserted within the antrum for elevation of fragments after uncomminuted fracture of the left malar bone; the fracture is three weeks old. Text on page 227.

Uncomminuted Fracture of Malar Bone Sustained Several Days before Treatment (Fig. 100)

COMMENTS AND TREATMENT

Simple fractures of the malar bone which cannot be reduced for two or three weeks following injury, require treatment other than elevation by means of a hook or forceps. When it is necessary to defer treatment of a fractured, uncomminuted malar bone because of some other injury such as a fractured ethmoid bone, treatment is similar to that for comminuted malar bone.

Secure anteroposterior and vertical profile roentgenograms.

Carefully examine the movements and the level of the involved eyeball.

Preferably under intratracheal gas and ether anesthesia, make an incision through the upper bucco-alveolar fold within the mouth on the involved side.

By means of a blunt periosteal elevator or a large curet, push the soft tissues aside over the lower anterior portion of the maxilla and adjacent portion of the malar bone.

It frequently is not possible to gain sufficient access to the antral cavity to insert the index finger of one hand for manipulation of the malar bone. Consequently, it is necessary to insert a blunt instrument such as a periosteal elevator within the antrum to force the malar bone back into its original position (fig. 100). At times, considerable force is needed for reduction of the fracture and this is particularly true if the fracture is two or three weeks old.

While holding the fragment out in proper position, insert a Penrose drain within the antrum in such a manner that the drain forms a loop with its two free ends protruding through the incision in the mucous membrane and into the mouth; this drain permits escape of any purulent material that forms within the antrum. Insert a tight iodoform pack within the antrum for immobilization of the malar bone.

Do not remove the pack or drain for three weeks.

Several days after this operation, it is well again to determine the movements and level of the eyeball of the involved side.



Fig. 100.—A blunt elevator is inserted within the antrum for elevation of fragments after uncomminuted fracture of the left malar bone; the fracture is three weeks old. Text on page 227.

Old Depressed Fractured Malar Bone with External Deformity (Fig. 101)

COMMENTS

Old fractured and depressed malar bones, if the condition has persisted for several months or years, present difficult problems in treatment. Many surgeons have suggested refracturing the malar bone by means of a chisel inserted through small external skin incisions or through incisions within the mouth; the purpose of this procedure is to free the malar bone and replace it in its original position. Immobilization then is obtained by some external form of fixation or by means of a pack within the antrum. It has been our experience that such operations are of little value. It is not difficult to chisel the malar bone free but we have found that it still is impossible adequately to elevate the bone because of the dense scar tissue surrounding the old fractured surfaces. Consequently, we have discontinued the use of such surgical operations and we prefer to leave the old depressed malar bone entirely alone. In order to correct the external facial deformity, that is, the flattening of the cheek, we recommend the use of some tissue transplant such as a cartilage graft to build up the contour of the depressed cheek until it is symmetrical with the opposite side. This plastic procedure is discussed in chapter IX.

In cases of old fractured malar bones, in which there is some residual downward displacement of the level of the eyeball, a cartilage implant along the floor of the orbit to elevate the globe and the periosteal attachment of the inferior oblique muscle often is beneficial both in improving the external appearance of the orbital region and in overcoming some of the diplopia. This plastic procedure also is discussed in chapter IX.



Fig. 101.—Cartilage grafts build up the contour of the left malar bone which has been depressed by an old fracture. Text on page 229.

CHAPTER V

FRACTURES OF THE NASAL BONES AND NASAL SEPTUM

OF all the facial bones, none is fractured so frequently as are the bones of the nose. Traumatic injuries of nasal bones may vary from simple linear fracture without displacement to severe comminution and depression. As in the case of injuries of malar bones, fractures of the nasal bones often can be overlooked for a time because of the excessive swelling and ecchymosis of the overlying soft tissues; this is particularly true when there is but slight displacement of the bony fragments. However, when the swelling has disappeared, even a small amount of displacement of one or both nasal bones can produce conspicuous facial deformity. Consequently, the importance of careful nasal examination of any patient who has sustained a blow over the nose cannot be stressed too strongly.

Our experience has been that roentgenologic studies are not essential for diagnosis of a nasal fracture. Detailed physical examination of the nose will disclose all of the information that is necessary to carry out adequate treatment. Should a nasal fracture be associated with possible fracture of an ethmoid bone, then roentgenograms to reveal the ethmoid region are of the utmost importance.

The essential signs and symptoms of nasal fracture are swelling and ecchymosis of the overlying soft tissues, intranasal hemorrhage, deformity, possible crepitation on palpation and, occasionally, nasal obstruction.

Hemorrhage, the result of traumatic injury to the nose, usually is neither severe nor prolonged. Occasionally, however, due to tears in the mucosa which result from sharp fragments of bone, bleeding from the nose may be profuse and may be controllable only by insertion of a vaseline pack. In all cases of nasal fracture of any consequence, it probably is advisable to apply an external

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metal splint after reduction of the fractures, not only to immobilize the fragments but also to prevent formation of a hematoma in the subcutaneous tissues over the dorsum of the nose. Hematomas of the nasal septum are to be guarded against; when present, they require prompt incision and evacuation of the blood clot to obviate the possibility of infection of the hematoma, a potentially serious complication.

Nasal obstruction usually is the result of associated injury to the nasal septum. The obstruction can be due to fracture of the septum with displacement of the fragment, edema or submucous hematoma. It is surprising how often physicians fail to examine and treat injuries to the nasal septum which are associated with fractures of nasal bones. If deformities and subsequent obstruction to one or both nasal cavities are to be avoided, the care of every fractured nose should include examination and treatment of associated septal injuries.

Not infrequently, a fracture of the nose is associated with contusions or lacerations of the overlying soft tissues. Such injuries should be taken care of as soon as possible, and prior to reduction of the fractures themselves. Injuries to the cartilages forming the lower half and tip of the nose sometimes accompany fracture of nasal bones. If these cartilages are displaced, immediate treatment usually is of little value but the subsequent deformity can be corrected later on by plastic measures.

It is always preferable to reduce a nasal fracture within a few days after the injury, but there is never the urgency for early treatment here that there is in the case of fractures of malar bones. As a matter of fact, treatment can be deferred for two or three weeks if necessary, at which time satisfactory manipulation of the nasal bones still can be accomplished. However, after three to four weeks, primary management of the fractures is of little value; treatment is better deferred for several months, until all the induration and thickening in the nasal region have disappeared. Then, plastic procedures can be successfully undertaken to correct residual nasal deformities.

Based on treatment, we have found it convenient to group injuries of nasal bones in the following manner:

1. Simple fracture of one or both nasal bones, with or without injuries to the nasal septum.

2. Severely comminuted and depressed fracture of the nasal bones and septum with or without associated fracture of the ethmoid bone.

3. Old fracture of nasal bones producing external nasal deformities.

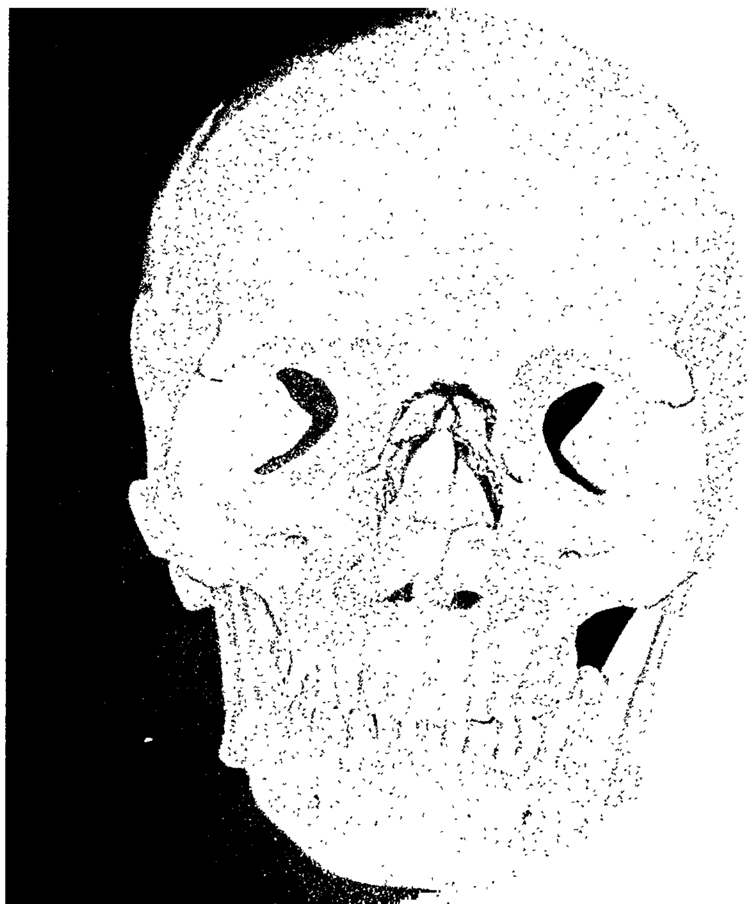


Fig. 102.—Text on page 235.

Simple Fracture of One or Both Nasal Bones, with or without Injuries to the Nasal Septum (Figs. 102 to 105 Inclusive)

COMMENTS

In some cases of simple, linear fracture of a nasal bone, there is no displacement of the fragments. However, in the great majority of cases of fracture of the nose, there exists some degree of mesial (inward) or lateral (outward) displacement. Unless such displacements are corrected, residual nasal deformities are bound to occur. Although multiple small fractures usually are present, extensive comminution of the nasal bones is not likely to occur unless the injury was due to a very severe blow over the bridge of the nose. External palpation and intranasal examinations reveal the displacement of the fragments.

In all cases of fracture of the nose, the condition of the nasal septum is extremely significant. Not infrequently there is an associated fracture of the septum, with overriding of the fragments or with displacement to one or the other side. In some instances, the lower attachment of the septum is completely displaced and deviated to one side. Not only should the septum be examined for possible fracture, with displacement of the fragments, but it is equally important to rule out the possible presence of submucous septal hematoma. Comminution of the septum is unlikely to occur unless there is severe comminution of the nasal bones as well. Following fractures of the septal cartilage high in the nose, some degree of saddle deformity of the nasal bridge may occur, while after fractures of the lower portion of the septum, adequate support for the tip of the nose may be lacking.

Treatment on pages 237 to 239 inclusive.



Fig. 102.—Text on page 235.

TREATMENT FOR SIMPLE FRACTURE OF ONE OR BOTH NASAL BONES AND THE NASAL SEPTUM (FIGS. 103, 104 and 105)

Ordinary fractures of nasal bones produce little shock and treatment can be begun at any convenient time.

In general, treatment of fracture of the nose does not require a great deal of time and reduction can be accomplished satisfactorily under local anesthesia. If intravenous anesthesia is employed, it is necessary to guard against the passage of blood into the throat and, at the same time, to maintain an adequate airway. In the average case, topical application of 10 per cent solution of cocaine to the nasal mucosa gives sufficient anesthesia for reduction of the fracture but in addition, subcutaneous injection of a small amount of procaine may be advisable for control of pain in some cases.

If one or both of the nasal bones is displaced mesially, insert a blunt periosteal elevator high up in the nose, between the septum and the depressed fragments. Then by outward pressure, the nasal bones are forced into their proper positions (fig. 103). If the nasal bones after such manipulation tend to become displaced mesially again, insert a vaseline pack high within the nose on the involved side for immobilization; this pack should be removed daily for seven to ten days following treatment.

If the nasal bones are displaced laterally, external pressure with the finger will readily reduce the fractures and restore the original contour of the nose. Unless the amount of displacement is very slight, an external metal splint held in position with adhesive tape as is represented in figure 105, is to be recommended. Such a splint not only immobilizes the nasal bones but also prevents subcutaneous hematoma.

If a fracture is found on examination of the nasal septum, an attempt should be made to replace the bony or cartilaginous fragments of the septum in proper alinement. This can be accomplished by means of two blunt elevators, one of which is inserted into each nostril, or by means of septum forceps, the beaks of which are covered with rubber. By such instruments, the displaced fragments of the septum can be forced into proper position (fig. 104).

Fig. 103.—Text on page 237.

Fig. 104.—Text on pages 237 and 239.

TREATMENT FOR SIMPLE FRACTURE OF ONE OR BOTH NASAL BONES, AND THE NASAL SEPTUM (*Continued*)

It is true, of course, that there is often a tendency of septal fragments to become displaced again in spite of the fact that vaseline packs are used on either side for immobilization. (If vaseline packs are employed, they should be removed and replaced daily for seven to ten days following treatment.) Treatment of residual deformities of the septum which produce nasal obstruction should be deferred for three or four months, at the end of which period, submucous resection can be performed.

Should submucous hematoma on either side of the septum arise, prompt incision and removal of the blood clot is to be recommended.

Immobilization of fractured nasal bones, by means of intranasal packs, an external metal splint, or both, need be maintained only for about ten days (fig. 105). After this time sufficient fibrous tissue will have formed to maintain the fragments in proper alinement.

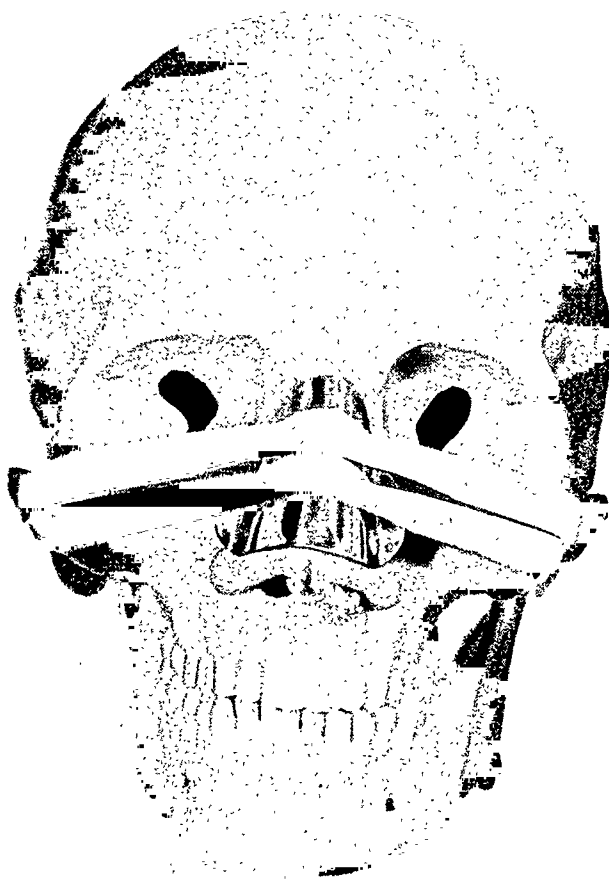


Fig. 105.—Text on pages 237 and 239.

SEVERELY COMMINUTED AND DEPRESSED FRACTURE OF THE NASAL BONES AND SEPTUM, WITH OR WITOUT ASSOCIATED FRACTURE OF THE ETHMOID BONE (FIGS. 106 TO 116 INCLUSIVE)

COMMENTS

In cases of severe fracture of the nose, such as occur in some automobile, airplane and tank crashes, the nasal bones and the nasal septum are so badly comminuted that ordinary methods of treatment are inadequate. Such fractures are often associated with exposure of the frontal sinus (fig. 106), but of more importance is the fact that occasionally in such cases the nasal bones are driven back into the ethmoid region, producing an associated fracture of the cribriform plate of the ethmoid bone. These are among the most serious of all injuries of facial bones (fig. 107).

It is a usual thing, following fracture of the ethmoid bone, for cerebrospinal fluid to drain from the nose for several days following the injury. Since cerebrospinal rhinorrhea is a sign of serious bony trauma in the ethmoid region and specific therapeutic management is required, its recognition in cases of severe injury to the nose cannot be stressed too strongly. As a matter of fact, an associated fracture of the cribriform plate of the ethmoid bone is of much greater consequence in the first two weeks of treatment of the patient than are the fractures of the nasal bones themselves. In every case in which the nasal bones are severely comminuted and depressed, the first step in diagnosis should be determination of whether or not cerebrospinal fluid is draining from one or both nasal cavities. Roentgenologic studies of the facial bones may be made subsequent to this examination. It frequently is difficult to distinguish cerebrospinal fluid that is draining from the nose from ordinary nasal mucus. A simple and effective method of differentiation was described in chapter I, according to which the patient should be placed in such a position that any discharge from the nose will drain onto a clean handkerchief. If the secretion is mucus it will stain the handkerchief and will change the texture of the material so that it appears to be starched. On the other hand, if the secretion is cerebrospinal fluid it will stain the handkerchief but will not change the texture of the cloth.

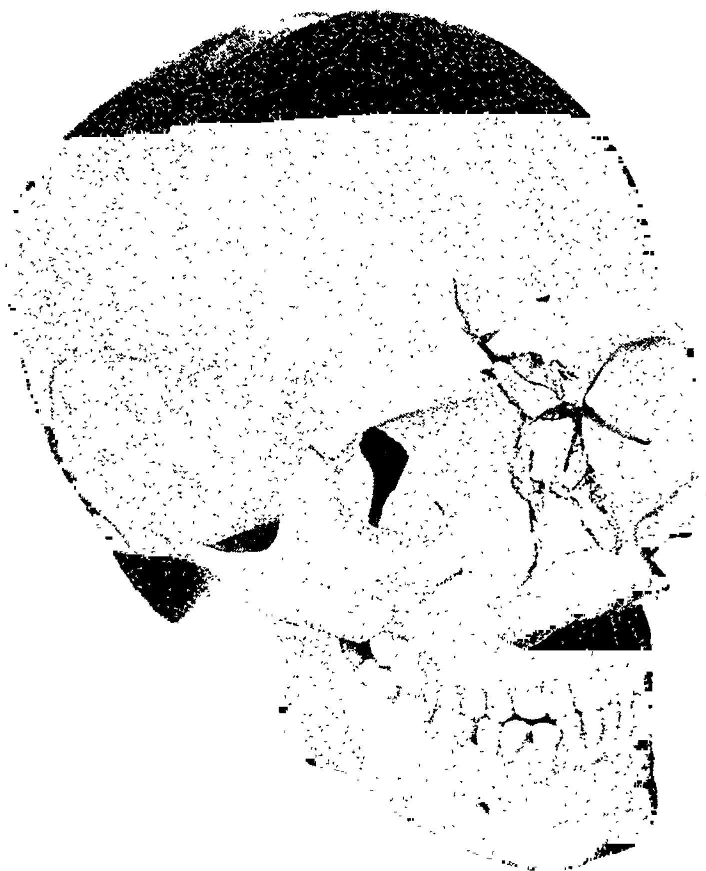


Fig. 106.—Text on pages 241 and 243.

COMMENTS (*Continued*)

Any patient with severe comminution and depression of the nasal bones may show definite signs of shock following the injury. Shock may be a serious condition when there is an associated fracture of the ethmoid bone. Consequently, the first consideration should be control of shock. Following such treatment the diagnosis of possible cerebrospinal rhinorrhea should be made, after which roentgenologic studies of the ethmoid and nasal regions are made. As was discussed in chapter I, if the roentgenogram reveals spicules of bone in the ethmoid region protruding upward into the substance of the brain, the patient should be referred to a neurosurgeon for surgical removal of these bony spicules. Any injuries or lacerations of the soft tissues overlying the nose should be taken care of under local anesthesia as soon as the patient's general condition will permit. However, if there is an associated fracture of the ethmoid bone, it is extremely important not to treat fractured nasal bones for from ten to fourteen days after the injury, because any manipulation of the nasal bones may disturb the fracture of the ethmoid bone and induce meningitis. As was discussed in chapter I, the fracture in the ethmoid region becomes walled off by fibrous tissue during the interval of waiting, and it is then safe to proceed with treatment of the fractured nasal bones. These and other considerations will be taken up in the following material on treatment, pages 244 to 255 inclusive.

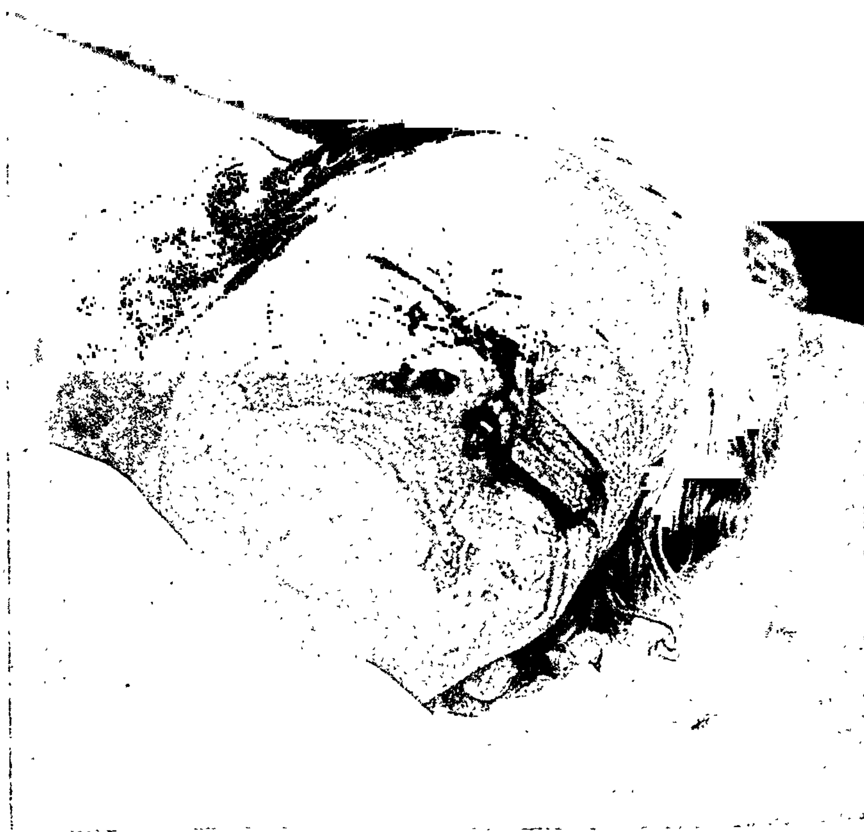


Fig. 107.—Text on pages 241 and 243.

TREATMENT FOR SEVERELY COMMINUTED AND DEPRESSED FRACTURE OF THE NASAL BONES AND SEPTUM, WITH OR WITHOUT ASSOCIATED FRACTURE OF THE ETHMOID BONE (FIGS. 108 to 116 INCLUSIVE)

Immediate Care of Patient.—As soon as symptoms of shock have been controlled, examine the patient's nose for possible drainage of cerebrospinal fluid which, if found, indicates associated fracture of the ethmoid bone. Obtain roentgenograms. If there is no ethmoid fracture, proceed with treatment of the fractured nasal bones at any convenient time. If a fractured ethmoid bone is present, treatment of the nasal bones should be deferred for two weeks, during which time one of the sulfa drugs should be administered as an aid in preventing meningitis. Wounds of soft tissue can be treated under local anesthesia as soon as the patient's general condition will permit.

Management of the Fractures.—Place a blunt elevator high within each nasal cavity to force the nasal bones outward; this, together with external finger pressure will mold the fragments into proper alinement. Since the septum is badly comminuted and gives no support to the nasal bones, some external form of fixation becomes necessary for immobilization of the nasal bones until healing has taken place. The apparatus that we have devised for this purpose consists of two parts: First, an appliance which holds the nasal bones forward and, second, a device for narrowing the nasal bridge. Many appliances for immobilization of severely comminuted nasal bones have been recommended, but the two parts of the apparatus represented in figure 108 and, to anticipate, in figures 110, 111, 114 and 115, have proved most satisfactory in our experience. These two mechanical devices should be used consecutively rather than concurrently, each being employed for about two weeks.

Primary Nasal Appliance.—After elevation of the nasal bones, the primary nasal appliance is placed in position for retaining the nasal bones in a forward position (figs. 108, 109 and 110).

Construct a plaster head cast in which is incorporated the metal band for retaining these nasal appliances (fig. 111). See pages 479 to 499 for details of construction of plaster head cast.

(Treatment is continued on page 249.)

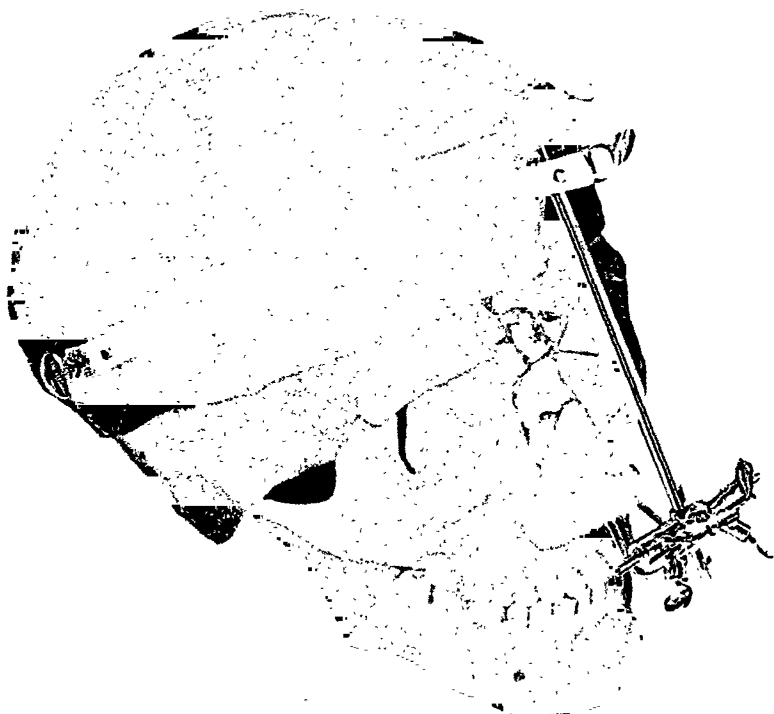


Fig. 108.—Appliance for retaining severely comminuted and depressed nasal bones in the desired forward position. Text on pages 245 and 249.

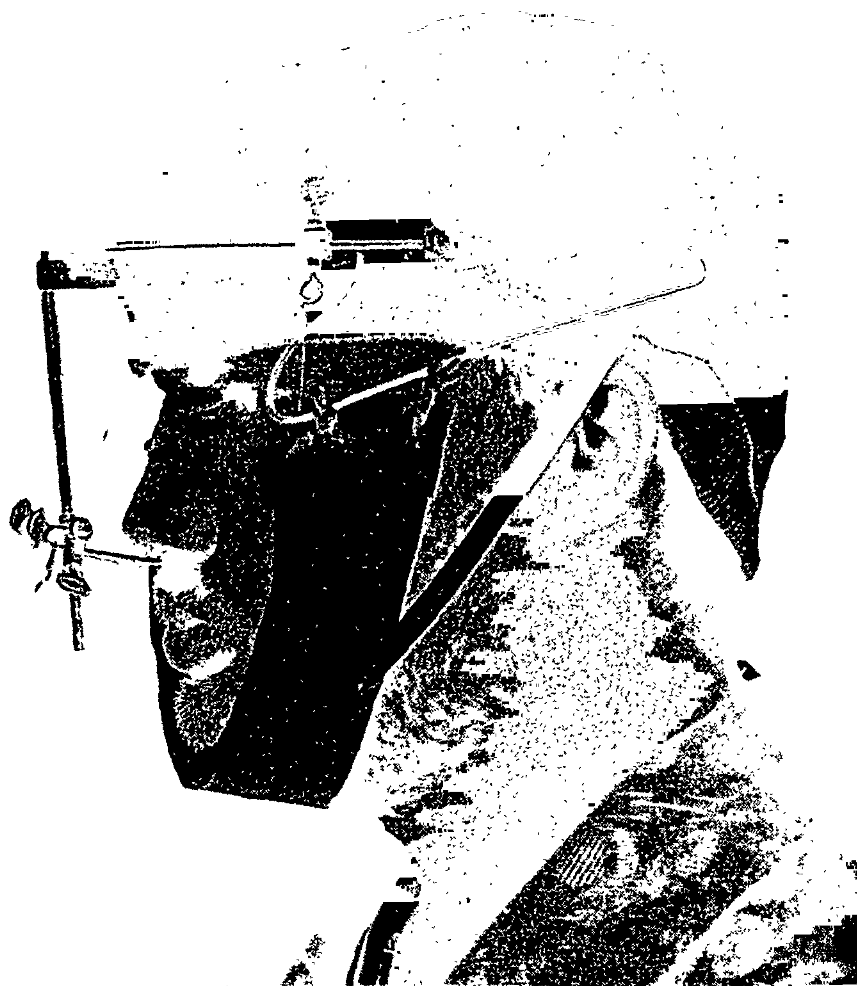


Fig. 110.—Same patient as the one represented in figure 109. This photograph illustrates how the nasal appliance retains nasal bones in forward position. This device is left in position for two weeks. Text on pages 245 and 249.



Fig. 109.—Patient with severe comminution and depression of nasal bones associated with a fractured ethmoid bone. Text on pages 245 and 249.

TREATMENT FOR SEVERELY COMMINUTED AND DEPRESSED FRACTURE OF THE NASAL BONES AND SEPTUM, WITH OR WITHOUT ASSOCIATED FRACTURE OF THE ETHMOID BONE (*Continued*)

Primary Nasal Appliance (*Continued from Page 245*).—Elevate the nasal bones as has been described and attach the primary nasal appliance to the central post of the plaster head cast. This device has two wires, each covered with a rubber catheter, one of which is intended to be inserted high into each nasal cavity; the appliance is so constructed that these wires can be rotated forward, thereby elevating the nasal bridge to the desired level (figs. 108, 110 and 111). Adjustments can be made at any time without removing or disturbing the appliance. See page 501 for details of this appliance. This nasal appliance should be left in position for about two weeks, at which time sufficient fibrous tissue has formed about the nasal bones to hold them forward without mechanical support.

If this appliance, or a similar one, is not available for holding the nasal bones forward, we have found that insertion of wires through the nose, as is illustrated in figures 112 and 113 is effective in retaining the nasal bones in a forward position until healing has taken place. On either side of the nose, a bronze or stainless steel wire is inserted, by means of a curved cutting needle, through the dorsum of the nose into the nasal cavity; the wire is brought out through the nostril, is threaded through a hole in an acrylic plug or splint, which later is inserted intranasally and, finally, is carried back into the nasal cavity and brought through the dorsum of the nose externally on a curved cutting needle. These wires on either side are then attached to an extension from a plaster head cast, and the acrylic splints are forced high into either nasal cavity. When traction is made on the wires, the nasal bones are elevated and immobilized. This method is somewhat crude but is very helpful in holding the nasal bones forward when no more refined appliance is available.

Any apparatus for holding the nasal bones forward has a tendency to broaden the nasal bridge. Consequently, after the primary nasal appliance has been removed, the second mechanism is necessary to narrow the bridge of the nose. See page 252.

(Treatment is continued on page 253.)

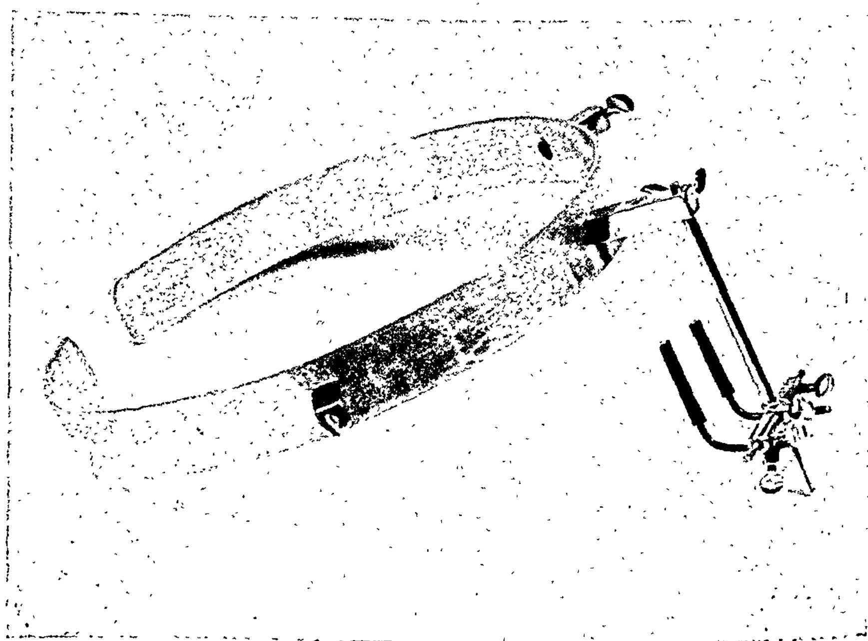


Fig. 111.—Appliance attached to central post or head band. The head band is designed to be incorporated in a plaster head case. Text on pages 245 and 249.

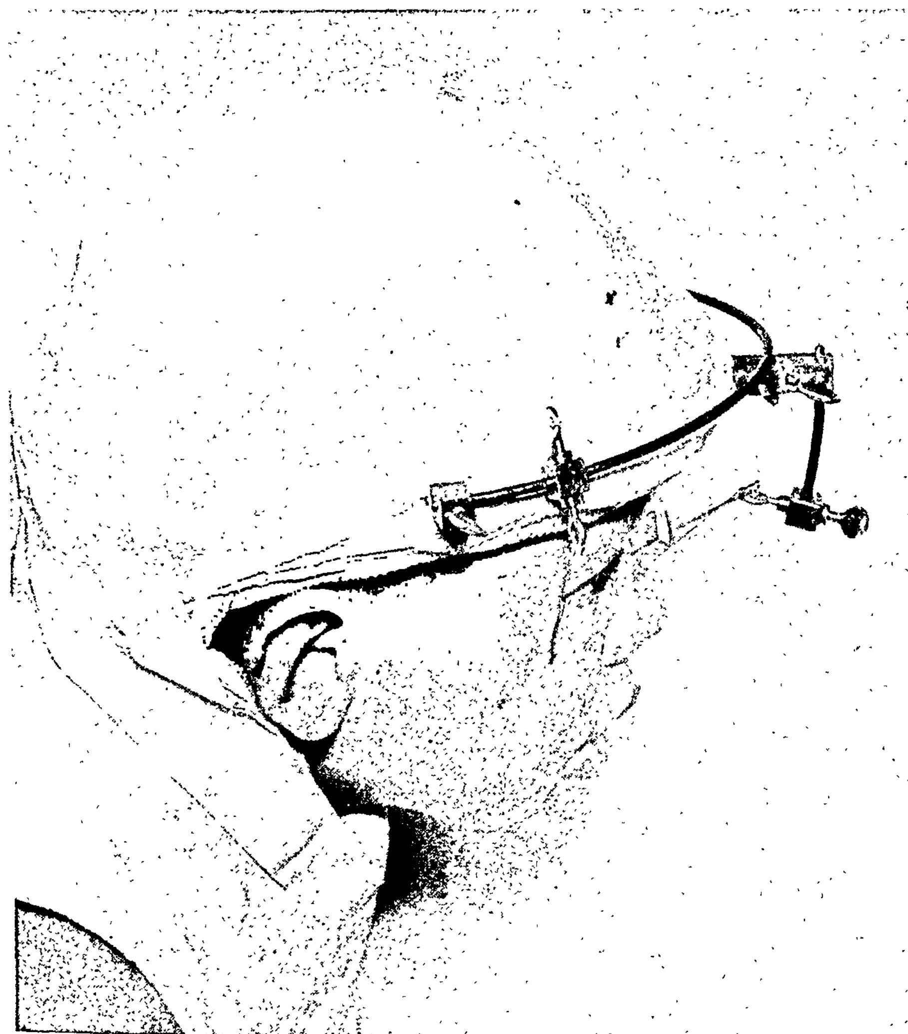


Fig. 113.—Child with severely comminuted fracture of the nasal bones. Wires inserted through the nose hold the nasal bones forward. See figure 112. Text on page 249.

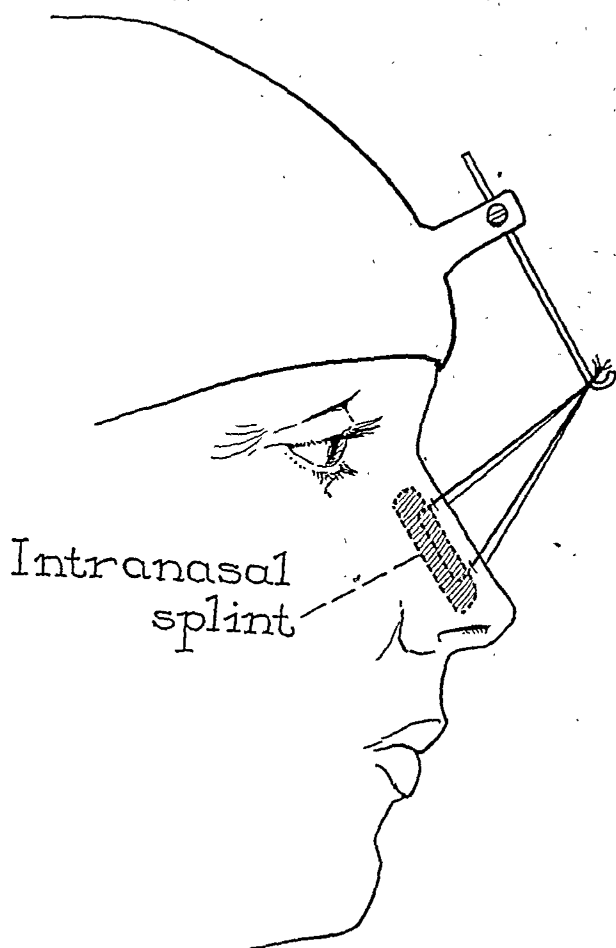


Fig. 112.—A method of holding severely comminuted and depressed nasal bones forward when the appliance shown in figure 108 is not available. Text on page 249.

TREATMENT FOR SEVERELY COMMINUTED AND DEPRESSED FRACTURE OF THE NASAL BONES AND SEPTUM, WITH OR WITHOUT ASSOCIATED FRACTURE OF THE ETHMOID BONE (*Continued*)

Secondary Nasal Appliance.—On removal of the first nasal appliance, the secondary nasal apparatus is placed in position and is attached to the central post on the plaster head cast (figs. 114 and 115). This appliance has two lateral pads which are adjustable and which make any desired degree of pressure on the sides of the nasal bridge. By giving the thumb set screws, which regulate the position of the lateral pads, a few turns daily for two or three days, the nose can be narrowed until it assumes normal proportions. See page 503 for details of this appliance. This secondary appliance is maintained in position for ten to fourteen days to immobilize the nasal bones.

If this or a similar apparatus is not available for narrowing the nasal bridge, a simple metal splint held in position with adhesive tape is helpful in preventing the nasal bones from flaring outward after the bridge has been narrowed by finger pressure (fig. 116).

By employing the two nasal appliances (figs. 108 and 114) in the early care of patients with severe comminution and depression of the nasal bones and septum, we have been able to correct completely, or to improve markedly, the nasal deformity produced by such injuries; in turn, we have been able to obviate the necessity of any, or of extensive, subsequent rhinoplastic surgical operation. It is true, of course, in some cases that, regardless of what appliance or what measures are used in the early care of these severe defects of the nose, residual nasal deformities are bound to occur. However, everything possible during the early treatment of the nasal injury should be undertaken to prevent subsequent nasal deformities; such management not only will greatly simplify, but also will augment the effectiveness of, later plastic repair.

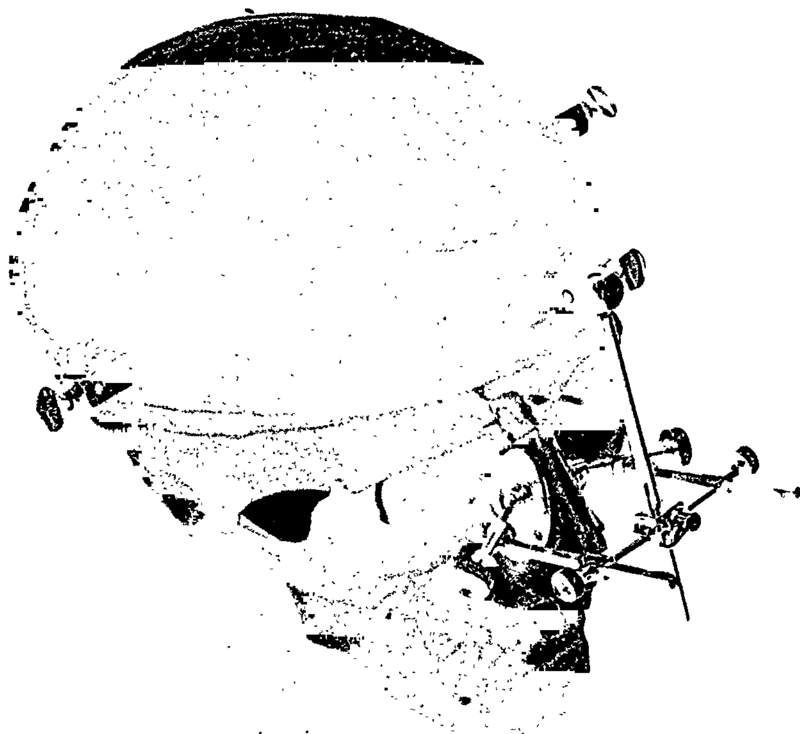


Fig. 114.—Appliance for narrowing and immobilizing the nasal bridge when severely comminuted. Text on page 253.



Fig. 116.—Splint for maintaining nasal bones in proper position after the bridge has been narrowed by finger pressure. Such a splint may be employed when the appliance shown in figures 114 and 115 is not available. Text on page 253.



Fig. 115.—Patient with severe comminution and depression of the nasal bones, associated with a pyramidal facial fracture and fracture of the ethmoid bone. Nasal bones have been elevated and retained in a forward position by the appliance shown in figures 108, 110 and 111. This illustration shows the secondary nasal appliance in position for narrowing the nasal bridge. Text on page 253.

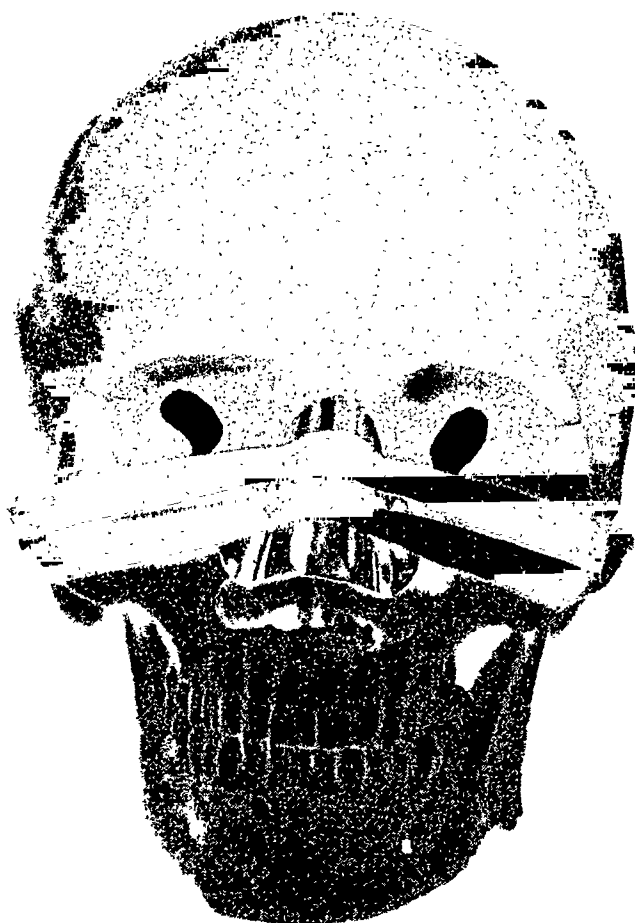


Fig. 116.—Splint for maintaining nasal bones in proper position after the bridge has been narrowed by finger pressure. Such a splint may be employed when the appliance shown in figures 114 and 115 is not available. Text on page 253.



Fig. 117.—Saddle nose. Text on page 257. See figure 118.

Old Fracture of Nasal Bones Producing External Nasal Deformities (Figs. 117 and 118)

COMMENTS

The great majority of deformities of the nose following fractures of nasal bones are due to neglect of the primary nasal fracture or are the result of poor immediate treatment. However, in an occasional case of fracture of the nose, even after the utmost care has been taken to restore the nasal bones to their original position, some deformity persists. If a patient wishes his nasal deformity corrected, it is preferable to wait at least six months after the accident before attempting plastic repair. The most commonly occurring traumatic nasal deformities are (1) the crooked nose, which may deviate to one or the other side and which is usually associated with deflection of the septum; (2) the hump nose, in which the nasal bones are abnormally elevated; (3) the bulbous or broad nasal tip, in which the lower lateral cartilages are markedly flared; (4) the saddle nose, in which the nasal bones or the lateral nasal cartilages are depressed, and (5) combinations of the foregoing deformities.

Treatment is referred to on page 259.



Fig. 118.—See figure 117. Saddle deformity of the nose, the result of a comminuted fracture of the nasal bones, corrected by a costal cartilage implant.

TREATMENT FOR OLD FRACTURES OF NASAL BONES PRODUCING EXTERNAL NASAL DEFORMITIES (FIG. 118)

The treatment of old nasal deformities is entirely too broad a subject to be discussed in this book; sufficient material is available on this topic to fill an entire volume. Suffice it to say here that displaced nasal bones are refractured and molded into their proper position; a prominent hump is removed by means of a saw or chisel and mallet, and a broad tip is corrected by readjustment of the lower lateral cartilages. Marked deflection of the septum which produces symptoms of nasal obstruction should be corrected by means of submucous resection. When a saddle deformity exists, either in the bony or cartilaginous portion of the bridge, the normal contour of the nose can be restored by means of a cartilage implant (fig. 118). Cartilage grafts to the nose are discussed in chapter IX, pages 470 to 477.

CHAPTER VI

FRACTURES OF BOTH JAWS

IN cases of fracture of both jaws, the routine management of each separate fracture, as this has been described in previous chapters, is not suitable, because in this situation the fractures cannot be treated as a collection of unrelated traumatic defects. On the contrary, the treatment must be arranged so as to care for both jaws as a structural unit.

In the treatment of fractures of both jaws, we have found it helpful to divide cases into three groups. The fundamental plan of treatment for the bony injuries in each group is essentially the same; this greatly simplifies and facilitates the method of approach in each case. It is preferable to base a systematic arrangement of cases of fracture of both jaws on the character of the injuries to the upper jaw rather than on the nature of the injuries to the mandible. Our classification is as follows:

1. Fracture of both jaws, including unilateral fracture of the upper jaw.

2. Fracture of both jaws, including a horizontal maxillary, a pyramidal facial, or a transverse facial fracture, or a combination of these fractures with no fractures of the palate. (If one or more palatal fractures is present, there must be no displacement of the palatal fragments if treatment is to be according to the plan to be suggested for this second group of fractures.)

3. Fracture of both jaws, including a horizontal maxillary fracture associated with one or more fractures of the palate and with displacement of the palatal fragments.

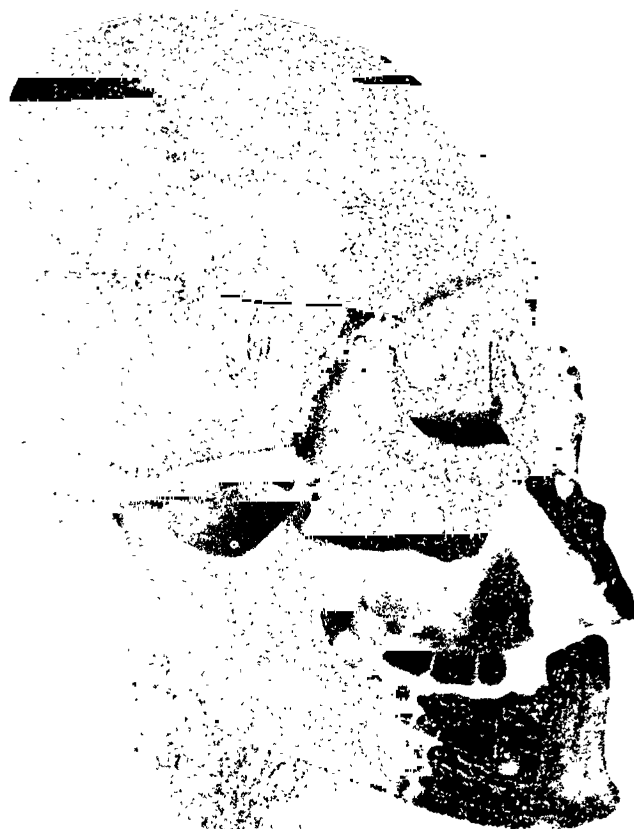


Fig. 110.—Text on pages 263 and 265

Fractures of Both Jaws Including Unilateral Fracture of the Upper Jaw (Figs. 119 to 126 Inclusive)

COMMENTS

Because the blow causing the injury is directed from the side, unilateral fracture of the upper jaw is frequently associated with one or more fractures of the lower jaw and, occasionally, with depressed fracture of the malar bone on the same side (fig. 119). For unilateral fracture of the maxilla, associated with one or more fractures of the mandible, we have found that the following therapeutic procedures are necessary:

1. The fractures of the lower jaw must be reduced and the fragments immobilized without the aid of intermaxillary rubber bands or wires. To secure immobilization of the fragments of the lower jaw under these circumstances, various methods, such as use of cast silver splints and external pin fixation may be required.

2. Manipulation usually is ineffective in reducing the fracture of the upper jaw; mechanical appliances are required to produce a desirable result. If the loose fragment of the upper jaw is displaced downward and inward (fig. 119), it first must be forced outward. For this purpose, we employ an orthodontia jackscrew, such as was described in chapter III, Problem 30 (fig. 120). Although this device will correct the mesial displacement, it will not rectify the downward displacement of this upper fragment. Consequently, when the patient closes his jaws the teeth of the loose upper fragment come in contact with the opposing lower teeth, leaving an open bite on the side of the mouth opposite to that of the loose fragment.

3. The unfractured half of the maxilla is the only portion of either jaw which is fixed and which occupies its original position. Consequently, when rubber bands are stretched between this part of the maxilla and the lower jaw, a strong upward pull is placed on the mandible (fig. 121); this traction, acting on the splinted lower jaw, forces the loose upper fragment up into proper position and, in turn, closes the open bite (fig. 122).



Fig. 120.—Text on pages 267, 260 and 270.

When teeth are missing from the lower jaw, as is represented in figure 119, there is no surface on which the teeth of the loose upper fragment can rest to hold this fragment up in position. Consequently, the edentulous region of the lower jaw must be filled in mechanically with some appliance which forms an occlusal plane on which the teeth of the loose upper fragment can rest (fig. 122).

Should a fractured malar bone be present, the fractures of the jaw should be taken care of before treatment of the malar bone is undertaken.

Management of the most commonly occurring fractures involving the mandible, which are associated with unilateral fracture of the upper jaw, is discussed in the following pages.



Fig. 121.—The open bite between the unfractured portion of the upper jaw and the mandible, due to downward displacement of the loose upper fragment of bone. The intermaxillary elastic traction pulls the lower jaw upward and, in turn, forces the upper fragment into proper position. Text on pages 267, 269 and 270.

TREATMENT FOR UNILATERAL FRACTURE OF UPPER JAW ASSOCIATED WITH FRACTURE OF MANDIBLE ON THE SAME SIDE. TEETH PRESENT IN BOTH LOWER FRAGMENTS (FIGS. 119 to 122 INCLUSIVE)

Immediate Care of the Patient.—A patient with the injuries being discussed here may exhibit some signs of shock. This condition should be controlled before proceeding with treatment.

Management of the Fractures.—It will be noted in figure 119 that, in addition to the fracture of the lower jaw, several lower teeth are missing. The splint which is constructed to immobilize the fragments of the lower jaw also should form an occlusal plane on which the teeth of the loose upper fragment can rest to hold this fragment up in proper position. The cast silver splint which we would employ for this purpose is described in detail on page 577 and is constructed in the following manner:

1. Obtain dental compound impressions of both jaws. If there is marked displacement of the upper fragment and of the two lower fragments, the impressions must be taken as is described in chapter VII, pages 305 to 321. Because of the displacement of the fragments, it is practically always impossible to obtain a satisfactory hydrocolloidal (dentocol) impression.
2. Prepare plaster models from the impressions.
3. Cut the plaster models at the sites of the fractures.
4. Mount the plaster fragments in proper relationship on a dental articulator.
5. Prepare a wax pattern for a one-piece silver splint. This splint should span the edentulous area and possess a lingual rest for the single tooth in the short posterior fragment. See page 577.
6. Cast a one-piece silver splint from the wax pattern. A sectional splint cannot be made in a case of this type because such a splint requires perfect hydrocolloidal (dentocol) impressions and necessitates mounting of the plaster fragments on the articulator in perfect approximation. Neither of these requirements can be met here. The splint should be in one piece and should fit merely over the occlusal half of the teeth in the long anterior lower fragment. It is retained by cement or by circumferential wires if necessary. The splint should possess hooks or buttons for attachment of elastic bands for intermaxillary traction and should be constructed as is described on page 577.



Fig. 122. Text on pages 269 and 270.

TREATMENT FOR UNILATERAL FRACTURE OF UPPER JAW ASSOCIATED WITH FRACTURE OF MANDIBLE ON THE SAME SIDE. TEETH PRESENT IN BOTH LOWER FRAGMENTS (*Continued*)

Before we digressed to give directions for construction of a cast silver splint, we described a fracture in association with which several lower teeth were missing. Under the conditions of this problem, if teeth have not been lost from the lower jaw, the same type of silver splint and immobilization for the fragments of the lower jaw is to be recommended.

Attach an anchor clamp band having a buccal sheath to the single tooth in the short posterior lower fragment (fig. 120).

Cement the silver splint to the teeth in the long anterior lower fragment (fig. 120). If the cement does not adequately stabilize the silver splint, one or two circumferential wires around the mandible and over the splint may be used to advantage.

Manipulate the lower fragments into proper approximation and connect the silver splint and molar band by means of a rod and wire. This technic is described in detail on page 577. By these appliances, the fragments of the lower jaw are perfectly immobilized and, across the edentulous part of the mandible, the splint forms an occlusal plane on which the teeth of the loose upper fragment can rest (fig. 120).

Attach an anchor clamp band having a buccal sheath to a molar tooth on either side of the upper jaw. On the lingual surface of each band, a pin should be soldered for reception of a jackscrew (fig. 120).

Attach a segment of a round wire arch bar to the teeth in the unfractured portion of the upper jaw; this arch bar can be completely stabilized if its distal end is inserted into the sheath of the molar band on the same side (fig. 120).

Insert a jackscrew between the two upper molar bands. On rotation of the nut on the jackscrew, the loose upper fragment is forced outward (fig. 120).

Stretch rubber bands between the hooks or buttons of the silver splint and the round wire arch bar above. Such elastic traction elevates the mandible and, by holding the mandible, with its splint, up beneath the maxillary fragment, gradually forces this fragment up into proper position and brings the entire lower

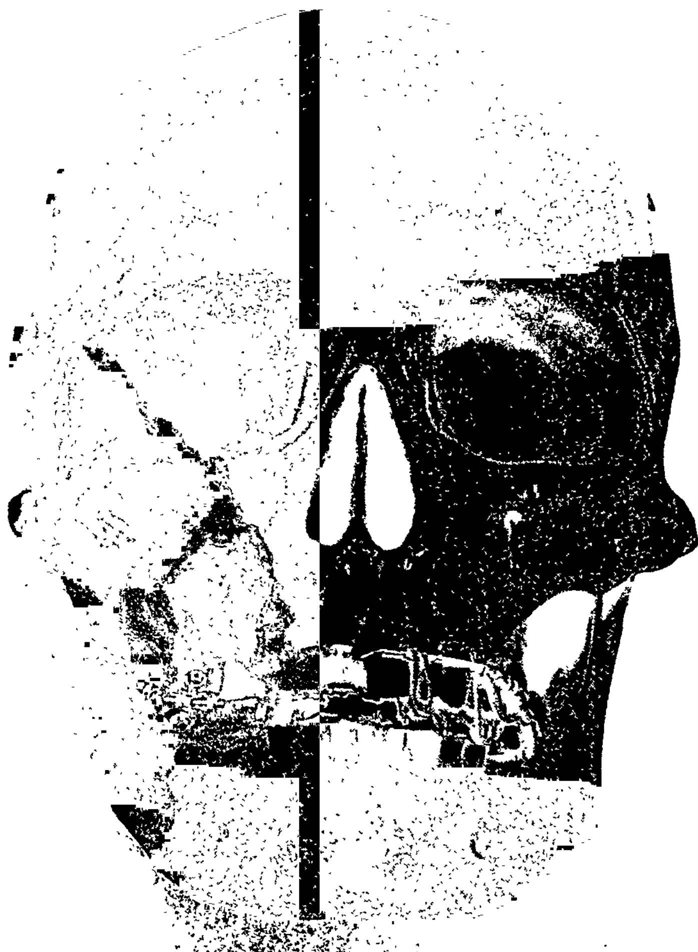


Fig. 122.—Text on pages 269 and 270.

TREATMENT FOR UNILATERAL FRACTURE OF UPPER JAW ASSOCIATED WITH FRACTURE OF MANDIBLE IN THE BICUSPID OR FIRST MOLAR REGION ON THE SAME SIDE. NO TEETH PRESENT IN SHORT POSTERIOR FRAGMENT (FIG. 123)

The treatment here is identical with that described on pages 267 to 270, except for the type of immobilization used on the fragment of the lower jaw. To immobilize the fragments of the lower jaw in this case, we recommend a one-piece cast silver splint which is cemented to the teeth in the long anterior fragment and which possesses a saddle to fit over the alveolar ridge of the short posterior fragment; the latter fragment is fixed to the splint by a circumferential wire. This splint is constructed in the following manner:

1. In dental compound obtain impressions of both jaws. If there is marked displacement of the upper fragment and of the two lower fragments, the impressions must be taken as is described in chapter VII, pages 305 to 321. Because of the displacement of the fragments, it is practically always impossible to obtain a satisfactory hydrocolloidal (dentocol) impression.
2. Prepare plaster models from the impressions.
3. Cut the plaster models at the sites of the fractures.
4. Mount the plaster fragments in proper relationship on a dental articulator.
5. Prepare a wax pattern for a one-piece silver splint.
6. Cast a one-piece silver splint from the wax pattern. A sectional splint cannot be made in a case of this type because such a splint requires perfect hydrocolloidal (dentocol) impressions and necessitates the mounting of the plaster fragments on the articulator in absolutely perfect approximation. Neither of these requirements can be met here. The saddle portion of this splint should be built up with silver or with vulcanite or one of the acrylic resins to form an occlusal plane on which the teeth of the loose upper fragment can rest to hold this fragment up in position (fig. 123). It is well to affix a loop on the buccal and lingual surfaces of the saddle portion of the splint; the circumferential wire can be attached to these loops and this obviates the necessity of carrying the circumferential wire over the occlusal portion of the splint to interfere with dental occlusion.

jaw into proper relationship with the upper dental arch (figs. 121 and 122).



Fig. 123.—Text on pages 271 and 272.

When the teeth are in occlusion, replace the intermaxillary rubber bands with double intermaxillary wires; at the same time, open the mouth just long enough to remove the jackscrew.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

TREATMENT FOR UNILATERAL FRACTURE OF UPPER JAW ASSOCIATED WITH FRACTURE NEAR ANGLE OF MANDIBLE. INVOLVED SIDE OF MANDIBLE IS EDENTULOUS (FIG. 124)

In the immobilization of the fragments of the lower jaw, the same type of one-piece cast silver splint as was described on page 271 is to be recommended. The short posterior fragment is immobilized by external pin fixation. The cast silver splint is made as is described on pages 575 to 579. It is well to affix a metal loop on the buccal surface of the saddle portion of the splint; this loop is valuable for the attachment of an intermaxillary wire to hold the loose upper fragment outward if it tends to become displaced mesially.

Drive a single pin into each lower fragment. In treating the type of fractured mandible under discussion, the skeletal fixation appliance furnishes immobilization that is merely supplementary to that obtained by the intermaxillary wires. Consequently, two pins in each fragment are unnecessary to secure thorough fixation. See pages 506 to 517 for details.

Cement the silver splint to the teeth in the long anterior fragment.

Attach an anchor clamp band having a buccal sheath to a molar tooth on either side of the upper jaw. On the lingual surface of each band, a pin should be soldered for reception of a jackscrew (fig. 120).

Attach a segment of a round wire arch bar to the teeth in the unfractured portion of the upper jaw; this arch bar can be completely stabilized if its distal end is inserted into the sheath of the molar band on the same side (fig. 120).

Insert a jackscrew between the two upper molar bands. On rotation of the nut on the jackscrew, the loose upper fragment is forced outward (fig. 120).

Stretch rubber bands between the hooks or buttons of the silver splint and the round wire arch bar above. Such elastic traction elevates the mandible; this gradually forces the loose upper fragment of bone up into proper position and brings the entire lower jaw into proper relationship with the upper dental arch (figs. 121 and 124).

The splint should possess hooks or buttons for intermaxillary elastic traction and should be constructed as is described on pages 575 to 579.



Fig. 124.—Text on pages 273 and 274.

This splint thoroughly immobilizes the fragments of the lower jaw. The remaining treatment in this case is identical with that described on pages 269 and 270.

TREATMENT FOR UNILATERAL FRACTURE OF UPPER JAW ASSOCIATED WITH FRACTURE NEAR ANGLE OF MANDIBLE. SUBSTANTIALLY THE FULL COMPLEMENT OF TEETH PRESENT (FIG. 125)

The treatment here is identical with that described on pages 267 to 270, except for the type of immobilization used for the fragments of the lower jaw.

Drive a single pin into each lower fragment. In treating the type of fractured mandible under discussion, the skeletal fixation appliance furnishes immobilization that is merely supplementary to that obtained by the intermaxillary wires. Consequently, two pins in each fragment are unnecessary to secure thorough fixation. See pages 506 to 517. Some surgeons may prefer two pins in each fragment, as is illustrated in figure 125, but we believe that this is not necessary.

Wire a hooked arch bar to the teeth in the lower dental arch. See page 527 for details.

Attach an anchor clamp band having a buccal sheath to a molar tooth on either side of the upper jaw. On the lingual surface of each band, a pin should be soldered for reception of a jackscrew (fig. 120).

Attach a segment of a round wire arch bar to the teeth in the unfractured portion of the upper jaw; this arch bar can be completely stabilized if its distal end is inserted into the sheath of the molar band on the same side (fig. 120).

Insert a jackscrew between the two upper molar bands. On rotation of the nut on the jackscrew, the loose upper fragment is forced outward (fig. 120).

Stretch rubber bands between the lower hooked arch bar and the round wire arch bar above. Such elastic traction elevates the mandible, thus gradually forcing the loose maxillary fragment of bone up into position and bringing the entire lower jaw into relationship with the upper dental arch (figs. 121 and 125).

When teeth are in occlusion, replace the intermaxillary rubber bands with double intermaxillary wires; at the same time, open the mouth just long enough to remove the jackscrew.

Manipulate the short lower posterior fragment into proper position and immobilize by a fixation rod fastened to the pins.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube

Replace the intermaxillary rubber bands with double intermaxillary wires; at the same time, open the mouth just long enough to remove the jackscrew.



Fig. 125.—Text on page 275.

Manipulate the short lower posterior fragment into proper position and immobilize by means of a fixation rod fastened to the two pins.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

TREATMENT FOR UNILATERAL FRACTURE OF UPPER JAW ASSOCIATED WITH MULTIPLE FRACTURES OF MANDIBLE (FIG. 126)

In this situation, the lower fragments require construction of a silver splint. Because there are no teeth on the right side of the lower jaw, the splint is constructed with a saddle to fit over the alveolar ridge. The saddle portion of this splint should be built up with silver or with vulcanite or with one of the acrylic resins to form an occlusal plane on which the teeth of the loose upper fragment can rest to hold this fragment up in position (fig. 126).

The fracture near the angle on the left side of the mandible in figure 126, can be immobilized by external pin fixation because the pins can be inserted without encroachment on the line of fracture. However, the multiple fragments on the right side cannot be immobilized by pin fixation because it would be impossible to insert pins in all of these small fragments without one or more pins being driven into a line of fracture; a pin in the line of fracture exposes the bone surrounding the pin to infection and possible necrosis. The fragments on the right side of the lower jaw also cannot be immobilized by circumferential wires because the pieces of bone are too small for satisfactory circumferential wiring. Consequently, there is no adequate means of immobilization of the fragments on the right side of the mandible which may or may not interfere with proper union of the lines of fracture.

Cement the silver splint to the teeth in the anterior dentulous fragment.

Drive a single pin into each fragment forming the fracture at the left angle of the mandible.

Attach an anchor clamp band having a buccal sheath to a molar tooth on either side of the upper jaw. On the lingual surface of each band, a pin should be soldered for the reception of a jackscrew (fig. 120).

Attach a segment of a round wire arch bar to the teeth in the unfractured portion of the upper jaw; this arch bar can be completely stabilized if its distal end is inserted into the sheath of the molar band on the same side (fig. 120).

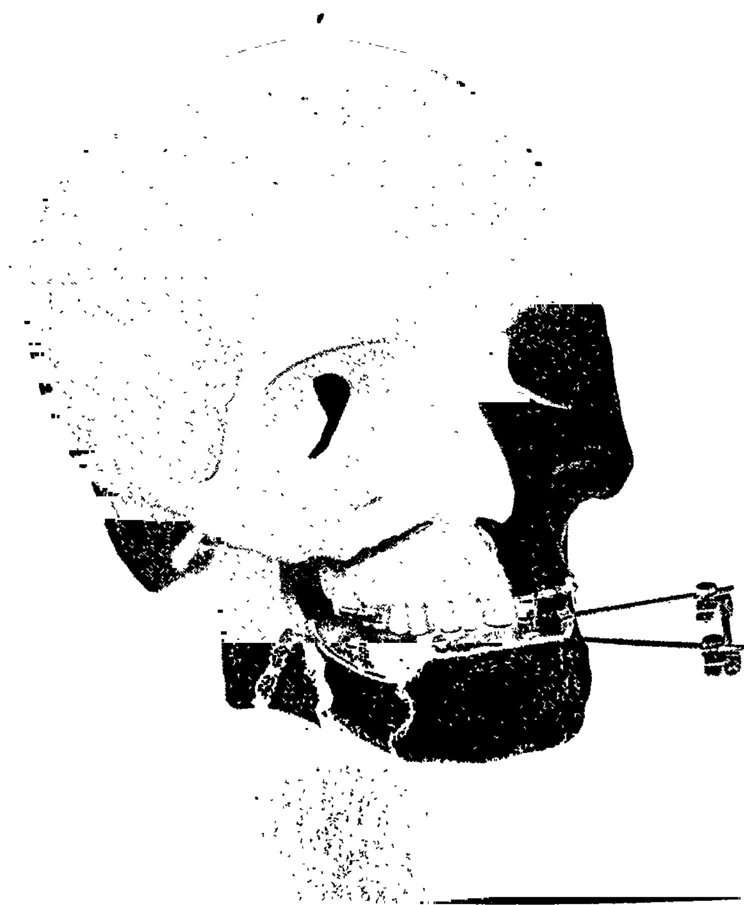


Fig. 126.—Text on pages 277 and 278.

Fractures of Both Jaws in Which There Is a Horizontal Maxillary, a Pyramidal Facial, or a Transverse Facial Fracture, or a Combination of These Fractures with no Fractures of the Palate (Figs. 127 to 131 Inclusive)

(Note: When one fracture of the palate is present, or more than one, there must be no displacement of the palatal fractures if the patient is to be treated according to the plan outlined here.)

COMMENTS

This is the second group mentioned on page 261.

In cases of horizontal maxillary, pyramidal facial, or transverse facial fracture, or a combination of these fractures, associated with one or more fractures of the mandible, treatment is not complex. However, should there also be present one or more fractures of the palate, with displacement of the palatal fragments, the technical care of the fractures is completely changed, a matter which is discussed in Problem 41 and chapter VII.

The therapeutic management of fractures of both jaws under the conditions of this problem requires, first, restoration of dental occlusion by intermaxillary elastic traction; second, immobilization of the upper jaw by the use of traction wires inserted through the cheeks from the upper arch bar on either side to a plaster head cast above, and third, fixation of the fragments of the lower jaw by intermaxillary wiring. If a posterior fragment in the lower jaw is edentulous and is displaced, it can be immobilized by external pin fixation.

If a pyramidal facial or transverse facial fracture is present, there is considerable danger of an associated fracture of the ethmoid bone. This very serious complication associated with pyramidal and transverse facial fractures has been discussed in Problem 27 of chapter III, which the reader should consult for detailed information. Here again the diagnosis of a fractured ethmoid bone, by means of roentgenologic studies and by examination of the nose for cerebrospinal rhinorrhea, is of great importance. Should such a fracture exist, here again treatment of the fractured facial bones should be deferred for two weeks and one of the sulfa drugs should be administered to aid in prevention of meningitis.

Insert a jackscrew between the two upper molar bands. On rotation of the nut on the jackscrew, the loose upper fragment is forced outward (fig. 120).

Stretch rubber bands between the hooks or buttons of the silver splint and the round wire arch bar above. Such elastic traction elevates the mandible and thus gradually the loose maxillary fragment of bone is forced up into proper position (figs. 121 and 126).

Replace the intermaxillary rubber bands with double intermaxillary wires; at the same time, open the mouth just long enough to remove the jackscrew.

Manipulate the left posterior fragment into proper position and immobilize by means of a fixation rod fastened to the two pins.

A felt chin sling held in position by light elastic traction bands fastened to strips of adhesive tape placed over the head may help in immobilizing the multiple fragments on the right side of the lower jaw (fig. 34).

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

PROBLEM 40

Illustrations on pages 280, 282, 284, 286 and 288.

TREATMENT FOR A HORIZONTAL MAXILLARY FRACTURE ASSOCIATED WITH FRACTURES OF MANDIBLE (FIG. 127)

Wire a hooked arch bar to the teeth in the uper dental arch and similarly attach a hooked arch bar to the teeth in the anterior fragment of the lower jaw (fig. 127).

Apply an anchor clamp band having a buccal sheath to a molar tooth in the dentulous posterior fragment. See page 529.

If the fragment posterior to the fracture, near the angle of the mandible, is pulled forward by muscular traction, this fragment is best immobilized by external pin fixation. Drive a single pin into each fragment formed by the fracture at the angle of the mandible. In treating this type of fractured mandible, the skeletal fixation appliance furnishes merely supplementary immobilization to that obtained by the intermaxillary wires. Consequently, two pins in each fragment are unnecessary.

Construct a plaster head cast in which is incorporated a metal band with posts for appliances. See pages 479 to 499.

Stretch rubber bands between the hooks of the upper and lower arch bars and between the upper arch bar and the sheath of the lower molar band. If the maxilla is displaced backward, a rubber band should be stretched from the upper arch bar to a rod attached to the plasted head cast (fig. 65). If the maxilla is displaced upward, a rubber band should be stretched from the upper arch bar to a curved rod attached to the head cast (fig. 67). This arrangement of rubber bands produces the necessary traction and brings the teeth into occlusion.

Insert traction wires through the cheeks. See pages 536 to 539. Attach the lower ends of these wires to the upper arch bar on either side, between the second bicuspid and the first molar tooth. Attach the upper ends of these wires to the turnbuckles on the adjustable hooks. Adjust the tension of the traction wires so as adequately to immobilize the upper jaw.

When the teeth are in occlusion, replace the intermaxillary elastic bands by double wires passed over the arch bars.

Manipulate the edentulous posterior fragment into proper position and immobilize by means of a fixation rod which is fastened to the two pins.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

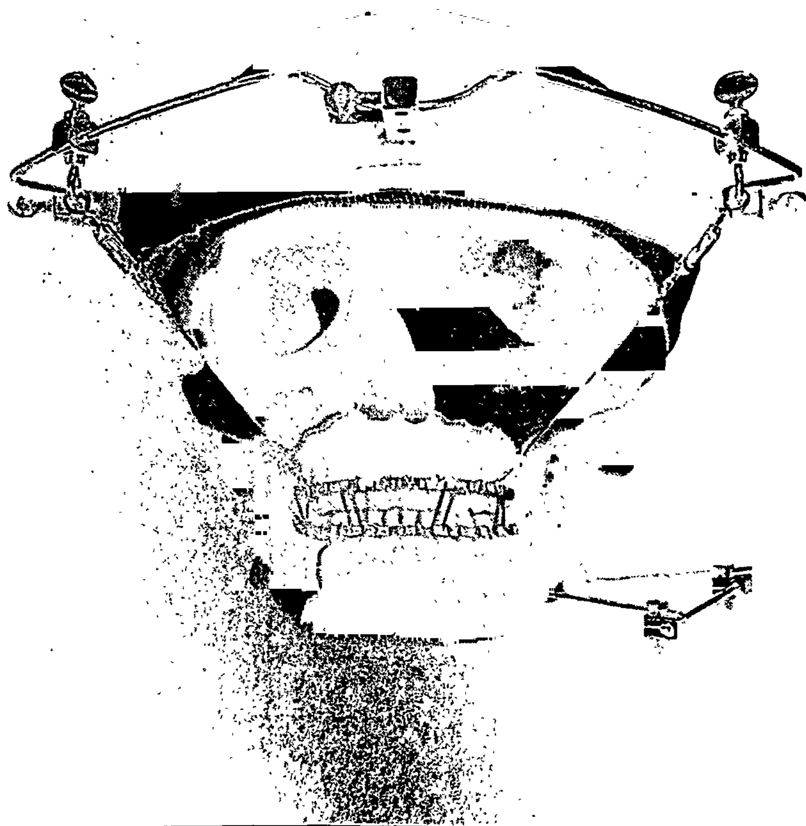


Fig. 127.—Text on page 281.

TREATMENT FOR A HORIZONTAL MAXILLARY FRACTURE ASSOCIATED WITH FRACTURES OF MANDIBLE (FIG. 127)

Wire a hooked arch bar to the teeth in the uper dental arch and similarly attach a hooked arch bar to the teeth in the anterior fragment of the lower jaw (fig. 127).

Apply an anchor clamp band having a buccal sheath to a molar tooth in the dentulous posterior fragment. See page 529.

If the fragment posterior to the fracture, near the angle of the mandible, is pulled forward by muscular traction, this fragment is best immobilized by external pin fixation. Drive a single pin into each fragment formed by the fracture at the angle of the mandible. In treating this type of fractured mandible, the skeletal fixation appliance furnishes merely supplementary immobilization to that obtained by the intermaxillary wires. Consequently, two pins in each fragment are unnecessary.

Construct a plaster head cast in which is incorporated a metal band with posts for appliances. See pages 479 to 499.

Stretch rubber bands between the hooks of the upper and lower arch bars and between the upper arch bar and the sheath of the lower molar band. If the maxilla is displaced backward, a rubber band should be stretched from the upper arch bar to a rod attached to the plasted head cast (fig. 65). If the maxilla is displaced upward, a rubber band should be stretched from the upper arch bar to a curved rod attached to the head cast (fig. 67). This arrangement of rubber bands produces the necessary traction and brings the teeth into occlusion.

Insert traction wires through the cheeks. See pages 536 to 539. Attach the lower ends of these wires to the upper arch bar on either side, between the second bicuspid and the first molar tooth. Attach the upper ends of these wires to the turnbuckles on the adjustable hooks. Adjust the tension of the traction wires so as adequately to immobilize the upper jaw.

When the teeth are in occlusion, replace the intermaxillary elastic bands by double wires passed over the arch bars.

Manipulate the edentulous posterior fragment into proper position and immobilize by means of a fixation rod which is fastened to the two pins.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.

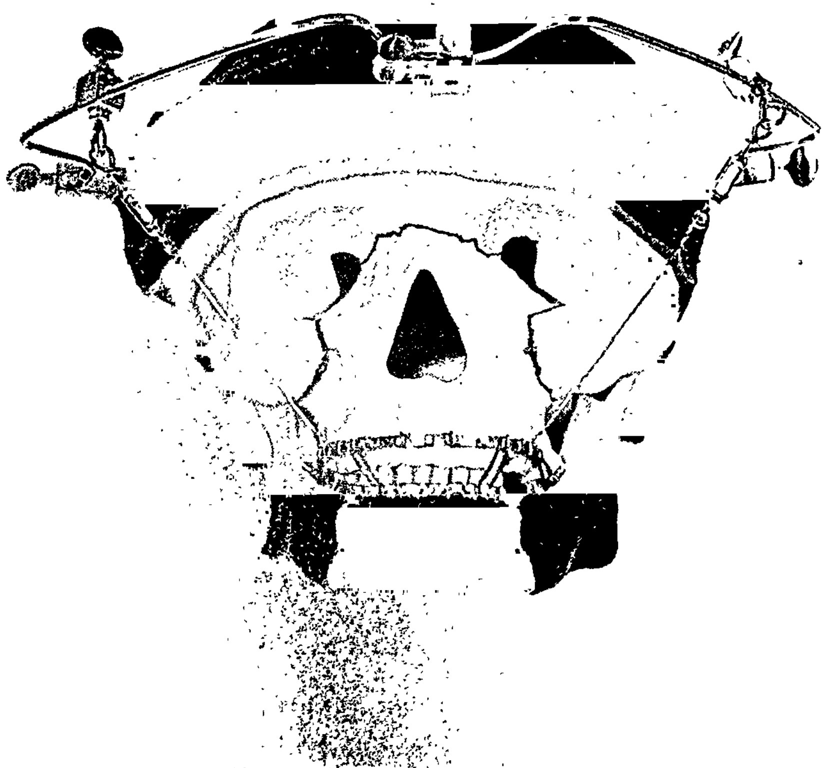


Fig. 128.—Text on page 283.

TREATMENT FOR A PYRAMIDAL FACIAL FRACTURE ASSOCIATED WITH FRACTURES OF THE MANDIBLE (FIG. 128)

Immediate Care of Patient.—As soon as symptoms of shock have been controlled, examine the patient's nose for possible drainage of cerebrospinal fluid, indicating associated fracture of the ethmoid bone. Obtain roentgenograms. If fracture of the ethmoid bone is present, treatment of the facial bones should be deferred for two weeks, during which time one of the sulfa drugs should be administered as an aid in preventing meningitis.

Management of the Fracture.—Wire a hooked arch bar to the teeth in the upper dental arch and similarly attach a hooked arch bar to the teeth of the lower anterior fragment. Apply an anchor clamp band to a molar tooth in each posterior fragment (fig. 128).

Construct a plaster head cast in which is incorporated the metal band with posts for attachment of appliances. See pages 479 to 499 for details.

For reduction, stretch rubber bands between hooks of the upper and lower arch bars. If the maxilla is displaced backward, a rubber band should be stretched from the upper arch bar to a rod attached to the plaster head cast (fig. 65). This arrangement of rubber bands produces the necessary traction to reduce the fracture and draw the teeth into proper occlusion.

For immobilization, insert traction wires through the cheeks. Attach the lower ends of these wires to the upper arch bar on either side, between the second biscuspid and the first molar tooth. Attach the upper ends of these wires to the turnbuckles on the adjustable hooks.

If the maxilla is displaced only slightly downward, give the turnbuckles a few turns on two or three successive days to elevate the upper jaw into proper position. If the maxilla is displaced markedly downward, unhitch each turnbuckle from its adjustable hook, shorten the traction wire so as to leave a space between the turnbuckle and the hook and stretch a strong rubber band across the space thus provided. These rubber bands produce a great amount of upward traction, sufficient to elevate the maxilla into proper position.

Maintain fixation for about four weeks.

Feed the patient a liquid diet through a straw or glass tube.



Fig. 129.—Subject referred to on page 285.

TREATMENT FOR A TRANSVERSE FACIAL FRACTURE ASSOCIATED WITH FRACTURES OF THE MANDIBLE (FIG. 129)

Immediate Care of Patient.—Same as that described on page 283.

Management of the Fracture.—Same as that described on page 283.



Fig. 130.—Text on page 287.

TREATMENT FOR HORIZONTAL MAXILLARY FRACTURE ASSOCIATED WITH FRACTURES OF THE MANDIBLE AND WITH ONE OR MORE FRACTURES OF THE PALATE, BUT WITHOUT DISPLACEMENT OF THE PALATAL FRAGMENTS (FIG. 130)

This is the only situation in which we would consider attaching an arch bar so as to cross a line of fracture. In a combination of fractures of the jaws such as is illustrated in fig. 130, if there is no displacement of the palatal fragments, the treatment is greatly simplified by wiring a hooked arch bar to all the teeth in the upper dental arch, permitting the bar to cross each palatal fracture. By this arrangement, the fractures of the palate are firmly immobilized and require no additional treatment. The remaining fractures then can be taken care of in a manner identical with that described on page 283.

The inadvisability of attaching a hooked arch bar to the upper dental arch so as to cross the palatal fractures, in the presence of displacement of the palatal fragments, is explained in Problem 41 and in chapter VII.



Fig. 130.—Text on page 287.

TREATMENT FOR A HORIZONTAL MAXILLARY, A PYRAMIDAL FACIAL, AND A TRANSVERSE FACIAL FRACTURE, ASSOCIATED WITH FRACTURES OF THE MANDIBLE AND WITH ONE OR MORE FRACTURES OF THE PALATE BUT WITHOUT DISPLACEMENT OF THE PALATAL FRAGMENTS (FIG. 131)

(Note: A pyramidal facial and a transverse facial fracture, when present in the same case, actually produce bilateral fractures of the malar bones.)

The treatment of a patient with multiple fractures of the facial bones such as are illustrated in figure 131 is not extremely difficult unless there is displacement of the palatal fragments. Under the latter circumstances, the technical care of the fractures is markedly changed, a matter which is discussed briefly in Problem 41 of this chapter and at length in chapter VII.

One important complication in the care of a patient with fractures of the facial bones such as are illustrated in figure 131 is the necessity of delaying treatment for fracture of the malar bones beyond the stage at which they can be satisfactorily elevated by means of a hook. The delay in this situation would be entirely due to associated fracture of the ethmoid bone which almost certainly would be present in this combination of facial fractures. Consequently, all treatment of the bony injuries would have to be postponed for two weeks, and thereafter elevation of the displaced malar bones would have to be deferred until the remaining fractures of the facial bones had been reduced. After this length of time, a total of about two and a half weeks, it would be impossible to elevate the malar bones by means of a hook; instead, surgical exposure of the antral cavities would be indicated to permit reduction of the malar fractures by intra-antral manipulation.

Our plan of treatment for a patient with fractures such as are illustrated in figure 131 is as follows:

Immediate Care of Patient.—As soon as symptoms of shock have been controlled, examine the patient's nose for the probable drainage of cerebrospinal fluid. If such drainage is taking place, it indicates an associated fracture of the ethmoid bone. Obtain roentgenograms to aid in this diagnosis. If a fracture of the ethmoid bone is present, as it probably would be, treatment of



Fig. 131.—Text on pages 289 to 292 inclusive.

its adjustable hook, shorten the traction wire so as to leave a space between the turnbuckle and the hook and stretch a strong rubber band across the space thus provided. These rubber bands produce a great amount of upward traction, sufficient to elevate the maxillary fragments into proper position.

The treatment thus far completes the reduction and immobilization of the fractures of the jaw. Because surgical exposure of the antral cavities, to elevate the malar bones, produces much bleeding into the mouth and throat, these operations are preferably performed under intratracheal gas and ether anesthesia which, when the pharynx is packed off with gauze, obviates the possibility of aspiration of blood into the trachea and bronchi. Due to the fact that the fragments of the upper jaw are suspended and immobilized by the traction wires attached to the upper arch bar, if the intermaxillary rubber bands are removed for insertion of an intratracheal anesthesia tube through the mouth, there is no displacement of the fragments of the upper jaw. Consequently, subsequent treatment of the patient is as follows:

Carefully examine the movements and level of both eyeballs before proceeding with treatment of the malar bones.

Remove the intermaxillary rubber bands, insert an intratracheal anesthesia tube through the mouth, and pack off the pharynx with gauze.

On one side make an incision through the upper bucco-alveolar fold within the mouth.

By means of a blunt periosteal elevator, or a large curet, push the soft tissues aside over the lower anterior portion of the maxilla and adjacent portion of the malar bone.

After gaining access to the interior of the antrum, either with the index finger of one hand or with a blunt instrument force the malar bone back into proper position.

While holding the fragment out in proper position, insert a Penrose drain within the antrum in such a manner that the drain forms a loop with its two free ends protruding through the incision in the mucous membrane and into the mouth; this drain permits escape of any purulent material that forms within the antrum. Insert a tight iodoform pack within the antrum for immobilization of the malar bone.

the facial bones should be deferred for two weeks, as has been said; during this time, one of the sulfa drugs should be administered as an aid in preventing meningitis. Wounds of the soft tissues can be treated under local anesthesia as soon as the patient's general condition will permit.

Management of the Fractures.—In this combination of fractures of facial bones, there may be fractures of the palate but, for this problem, the assumption is that there is no displacement of the palatal fragments. Consequently, a hooked arch bar may be wired to all of the teeth in the upper dental arch, regardless of the fact that this bar crosses the lines of fracture.

Wire a hooked arch bar to the teeth in the lower anterior fragment. See pages 526 to 528 for details.

Attach an anchor clamp band having a buccal sheath to a molar tooth in each posterior fragment. See page 529 for details. (Note: If one or both of the posterior fragments are edentulous, or if the fractures of the mandible are close to the angle, the posterior fragments can be immobilized by external pin fixation, one pin in each fragment being sufficient for adequate fixation.)

Construct a plaster head cast in which is incorporated a metal band with posts for attachment of appliances. See pages 479 to 499 for details.

For reduction, stretch rubber bands between hooks of the upper and lower arch bars (see pages 526 to 528). If the maxilla is displaced backward, a rubber band should be stretched from the upper arch bar to a rod attached to the plaster head cast (fig. 65). This arrangement of rubber bands produces the necessary traction to bring the teeth in the various fragments of the jaw into proper occlusion.

For immobilization, insert traction wires through the cheeks. See pages 536 to 539. Attach the lower ends of these wires to the upper arch bar on either side, between the second bicuspid and the first molar tooth. Attach the upper ends of these wires to the turnbuckles on the adjustable hooks (fig. 131).

If the maxillary fragments are displaced only slightly downward, give the turnbuckles a few turns on two or three successive days to elevate the upper jaw into proper position. If the maxilla is displaced markedly downward, unhitch each turnbuckle from

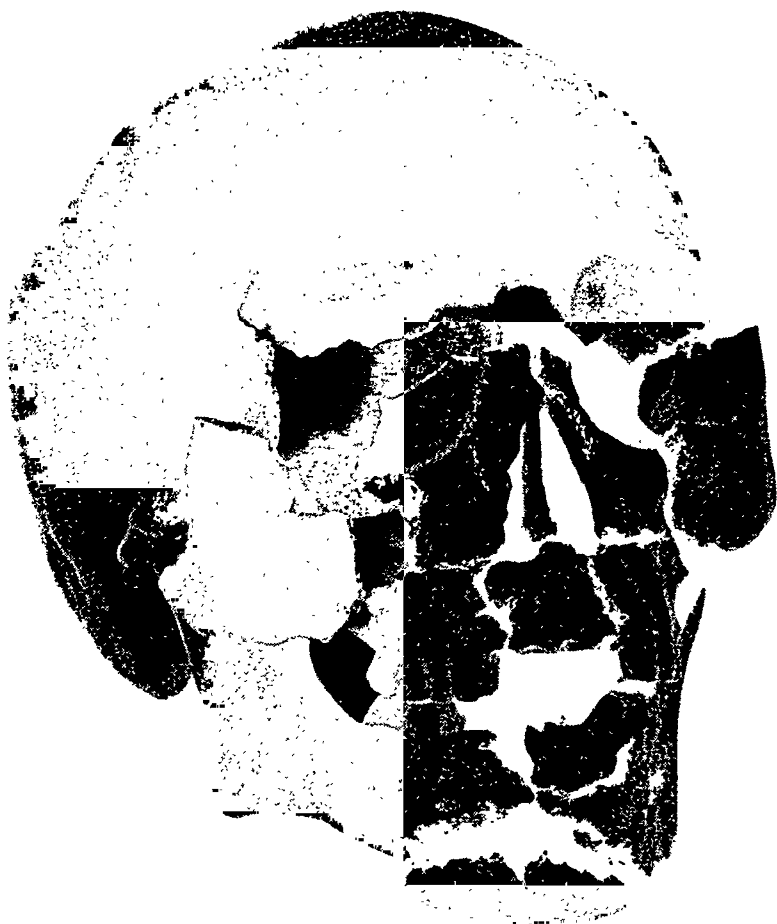


Fig. 132.—Text on page 295.

At the same operation, repeat the above surgical technic for elevation of the malar bone on the opposite side.

If the nasal bones are fractured, they can be elevated at this time.

Remove the intratracheal anesthesia tube, and leave the mouth free to be opened until the patient is past the stage of nausea.

Replace the intermaxillary rubber bands used to bring the fragments of the lower jaw back into proper relationship with the upper dental arch.

Maintain fixation of the fragments of the jaw for four weeks.

Remove the packs for immobilization of the malar bones three weeks from the time of their insertion.

Feed the patient a liquid diet through a straw or glass tube.

Fractures of Both Jaws, Including a Horizontal Maxillary Fracture Associated with One Or More Fractures of the Palate and with Displacement of the Palatal Fragments (Figs. 132 and 133)

COMMENTS

This is the third group mentioned on page 261.

In cases of fracture of both jaws, including a horizontal maxillary fracture associated with one or more fractures of the palate, and with displacement of the palatal fragments, not only is the original plane of dental occlusion and the contour of the dental arches lost but, also, there is no fixed point to which elastic bands can be applied for reduction and immobilization of the fractures.

For adequate reduction and immobilization, we prefer to employ a cast silver bite splint which is suspended by traction wires through the cheeks from a plaster head cast above (fig. 133). Because a patient with fractures of both jaws under the circumstances being discussed here invariably has associated fractures of the malar and nasal bones, we shall not discuss the treatment for this particular problem here; the therapeutic management of such cases is discussed in detail in the following chapter (chapter VII).



Fig. 133.—Text on page 295.

CHAPTER VII

MULTIPLE FRACTURES OF THE FACIAL BONES

PROBLEM 42

FRACTURES OF ALL THE FACIAL BONES INCLUDING THE ETHMOID BONE (FIGS. 134 TO 196 INCLUSIVE)

PROBABLY no patients with injuries of the face are more neglected than those with fractures of all the facial bones including the ethmoid bone (fig. 134). Multiple bony injuries of this sort are not of uncommon occurrence in modern warfare, particularly in airplane and tank crashes, and not infrequently result from automobile accidents. In the not distant past, peculiarly enough, there seems to have been no distinct interest in these severe injuries. A few wires were applied for immobilization of the fragments of the jaw and some attempts to elevate depressed malar and nasal bones were made. Little thought, however, was given to an organized and systematic plan of treatment aimed at complete reduction of the fractures, re-establishment of normal function of the jaws and restoration of facial contour. Unless such injuries are properly managed, subsequent facial deformities are unavoidable.

Ineffectual treatment in these cases has two causes. First, is the want of a systematic and orderly plan of therapy; second, is the need of a technic to care for all of the facial bones as a structural unit rather than a technic by which the various bony injuries are treated as a collection of unrelated traumatic defects. The difficulties which are encountered without an organized method of therapy in these cases are many. At the very begining, treatment of the facial bones must be postponed for two weeks for fear of disturbing the fractured ethmoid bone and inducing meningitis; this necessary delay complicates reduction,

particularly of the malar bones. Then there arises the problem of dental occlusion. Because the fragments of both fractured jaws are loose and displaced, there is no fixed point to which elastic bands can be attached for reduction of the fractures of the jaws. In addition, the original plane of occlusion and the contour of the dental arches has been lost. Due to the time which elapses between injury and treatment, displaced malar bones must be elevated by intra-antral manipulation, whether or not the bones are comminuted. Such management necessitates surgical exposure of the antral cavities under general anesthesia and is accompanied by much bleeding into the mouth and throat; if the teeth have been wired together, it is not safe to proceed with elevation of the malar bones by this method for fear of aspiration of blood into the trachea while the patient is under anesthesia. On the other hand, if the intermaxillary wires which hold the fragments of the jaw in position are removed temporarily to permit elevation of the malar bones, then the fragments of the upper jaw may become displaced again. This, in turn, prevents proper reduction of the malar fractures.

It is evident, therefore, that the problems which arise in the care of patients with fractures of all the facial bones, including the ethmoid bone, are complex. However, we have been able to solve these difficulties to our satisfaction by the use of a cast silver bite splint connected, by traction wires inserted through the cheeks, to a plaster head cast (fig. 133), and by a systematic plan of treatment. The type of silver splint to which reference has been made, together with a logical arrangement of procedures to care for the various injured facial bones, furnishes a form of therapy which insures reduction of all of the fractures with minimal residual deformity. We do not wish to convey the impression that this scheme represents the only satisfactory plan of therapy for these patients with multiple fractures of the facial bones but it is a method which has enabled us to care for these patients in a manner that leads to a desirable and creditable result.

The greatest single technical difficulty which arises in treatment in these cases is the problem of mounting plaster dental models, prepared from impressions in dental compound, on a dental articulator in such a manner that the original contour of the dental arches, as well as occlusion of the teeth, is re-



Fig. 134.—Text on page 297.

established. Unless the plaster models can be mounted so as to meet requirements, it is useless to proceed with preparation of the silver splint. If plaster models are constructed from individual impressions of each dentulous fragment, it is impossible to aline these plaster casts on an articulator in normal relationship because there is no way of determining the original contour of the dental arches (fig. 135). However, if by some mechanical means it is possible to adjust the fragments in the patient's mouth so that an impression, either of the upper or lower teeth, will reveal the original contour of the dental arches, then it is a simple procedure to mount the upper and lower plaster fragments in proper position on an articulator (fig. 136). The difficulty in securing such an impression is the result of the horizontal displacement of the fragments. With but rare exception, as is described on pages 305 to 307, it is possible to correct sufficiently the horizontal displacement of the fragments in one or the other jaw so as to obtain a single impression that exhibits not only the teeth which are present but also the original contour of the dental arch. Any vertical displacement of the fragments in this arch is of no concern since this can be corrected readily in the plaster model. See pages 315 to 317.

Our plan of treatment for patients with fractures of all the facial bones, including the ethmoid bone, from the time of the injury until completion of treatment, is described and illustrated chronologically in the following pages (figs. 137 to 196).

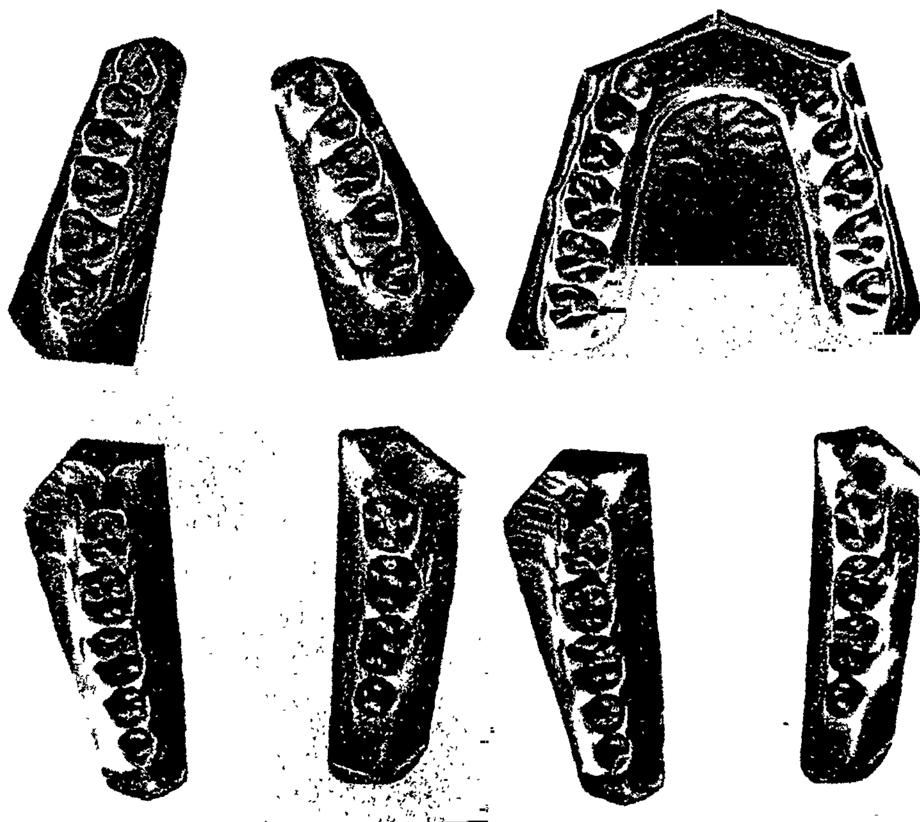


Fig. 135. Fig. 136.

Fig. 135.—Text on pages 299 and 301.
Fig. 136.—Text on pages 299 and 301.

TREATMENT FOR FRACTURES OF ALL THE FACIAL BONES, INCLUDING THE ETHMOID BONE (FIGS. 137 to 196 INCLUSIVE)

In this particular case, illustrated in figures 137 and 138, there are present the three types of facial fractures which produce complete separation of the upper jaw from the rest of the skull, that is; a horizontal maxillary fracture, a pyramidal facial fracture and a transverse facial fracture. In addition to multiple fractures of the mandible, there are also present a comminuted fracture of the left malar bone, a depressed fracture of the right malar bone, multiple and comminuted fractures of the nasal bones, with exposure of the frontal sinus, and a fracture of the cribriform plate of the ethmoid bone.

Treatment Immediately Following the Injury.—1. Treat the patient for shock. Disregard the injuries of the facial bones temporarily and control hemorrhage from the wounds in the soft tissues.

2. As soon as symptoms of shock have been controlled, examine the patient's nose for drainage of cerebrospinal fluid, which would indicate a fractured ethmoid bone.

3. Obtain roentgenograms if the patient's general condition will permit. If any fragments of the ethmoid bone appear to protrude into the brain tissue, consultation with a neurosurgeon is advisable.

4. Administer one of the sulfa drugs to prevent meningitis.

Treatment for the Two Weeks Following the Injury.—1. If, because of the patient's condition, roentgenograms could not be taken immediately following the injury, they should be taken as soon as is practicable.

2. On the first day after that of the injury, wounds of soft tissue should be sutured and treated with the patient under local anesthesia, if his general condition will permit.

3. Manipulation of the facial bones should not be attempted in the course of these two weeks, because of the possibility of disturbing the ethmoid fracture and inducing meningitis.

4. Continue the administration of the sulfa drug for these two weeks as an aid in the prevention of meningitis.



Fig. 137.—Text on page 303.



Fig. 138.—Text on page 303.

Treatment from Beginning of Third Week to Completion.—The treatment for the fractures is based primarily on the use of a cast silver bite splint which is attached by traction wires inserted through the cheeks to a plaster head cast. A few lines of explanation may properly precede the step by step therapeutic directions which compose the bulk of this chapter.

The splint, together with the traction wires, is employed to elevate, suspend and immobilize all of the fragments of the upper jaw. It permits opening of the patient's mouth, without disturbing the fragments of the upper jaw. For this reason, insertion of an intratracheal anesthesia tube is expedited. This tube is helpful during surgical elevation of the malar and nasal bones.

As was discussed on page 301, preparation of the splint calls for one dental impression, either upper or lower, that reveals the complete and original contour of the dental arch. Because all of the fragments in both jaws are displaced, with loss of the normal contour of both dental arches, the horizontal displacement of fragments in one or the other jaw must be corrected in order to obtain an impression exhibiting the original contour of the dental arch. In the case represented here, the horizontal displacement of the fragments of the upper jaw was rectified by a jackscrew to re-establish the contour of the upper dental arch.

A jackscrew may be employed for this purpose when the fragments are displaced mesially. If the fragments were malposed in an outward direction, elastic traction between two hooks attached on the lingual aspects of these fragments would be necessary (fig. 75). If the upper alveolar process were shattered, then it would be necessary to correct the displacement of the fragments of the lower jaw in order to obtain one impression revealing the original contour of the dental arches.

The remainder of this chapter is to be read in close association with the illustrations.

Figure 139.—An anchor clamp band having a buccal sheath is attached to a molar tooth in each lateral upper fragment. On the lingual surface of each of these bands, a small pin should be soldered for the reception of a jackscrew.

Figure 140.—An orthodontia jackscrew is interposed between these two molar bands. The fragments should be forced apart until the contour of the upper dental arch appears normal.



Fig. 139.—Text on page 305.

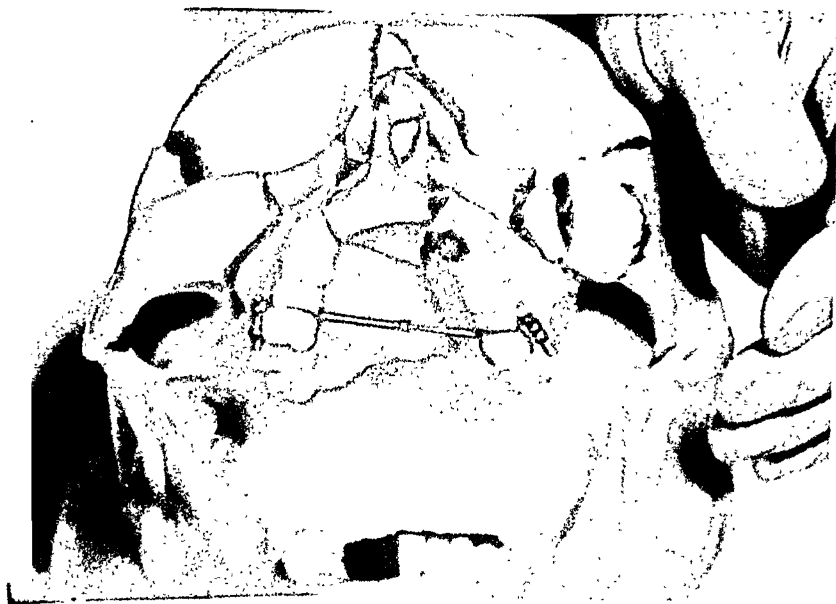


Fig. 140.—Text on page 305.

Figure 141.—After the upper fragments have been forced apart by means of the jackscrew, an impression of the upper dental arch is made in dental compound. Any vertical displacement of the fragments of the upper jaw can be corrected in the plaster model which is prepared from this impression in dental compound. Before the upper impression is taken, dental compound should be packed around the sheaths of the molar bands and under the jackscrew to avoid undercut, which would make withdrawal of the impression from the mouth impossible. This could not be illustrated in the model.

Figure 142.—The dental impression is removed from the mouth. Due to the marked displacement of the bony fragments, it usually is not possible to obtain satisfactory hydrocolloidal (dentocol) impressions in a case of this type. However, dental compound gives an adequate impression of the occlusal surfaces of the teeth, which is all that is necessary to construct the silver bite splint.



Fig. 141.—Text on page 307.



Fig. 142.—Text on page 307.

Figure 143.—An impression of the teeth of the left lower fragment is obtained in dental compound. Since a full upper impression has been secured, it is not necessary to take one of the complete lower arch. Consequently, individual impressions of the teeth in each fragment of the lower jaw should be secured. Crown and bridge trays for holding the dental compound work out very well for this purpose.

Figure 144.—The impression of the teeth in the left lower fragment is removed from the mouth.



Fig. 143.—Text on page 309.



Fig. 144.—Text on page 309.

Figure 143.—An impression of the teeth of the left lower fragment is obtained in dental compound. Since a full upper impression has been secured, it is not necessary to take one of the complete lower arch. Consequently, individual impressions of the teeth in each fragment of the lower jaw should be secured. Crown and bridge trays for holding the dental compound work out very well for this purpose.

Figure 144.—The impression of the teeth in the left lower fragment is removed from the mouth.



Fig. 143.—Text on page 309.



Fig. 144.—Text on page 309.

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Figure 144.—The impression of the teeth in the left lower fragment is removed from the mouth.



Fig. 143.—Text on page 309.



Fig. 144.—Text on page 309.

Figure 145.—An impression of the teeth of the right lower fragment is obtained in dental compound.

Figure 146.—The impression of the teeth in the right lower fragment is removed from the mouth.

Now that both upper and lower dental impressions have been secured, the jackscrew and anchor bands may be removed from the upper teeth.



Fig. 145.—Text on page 311.

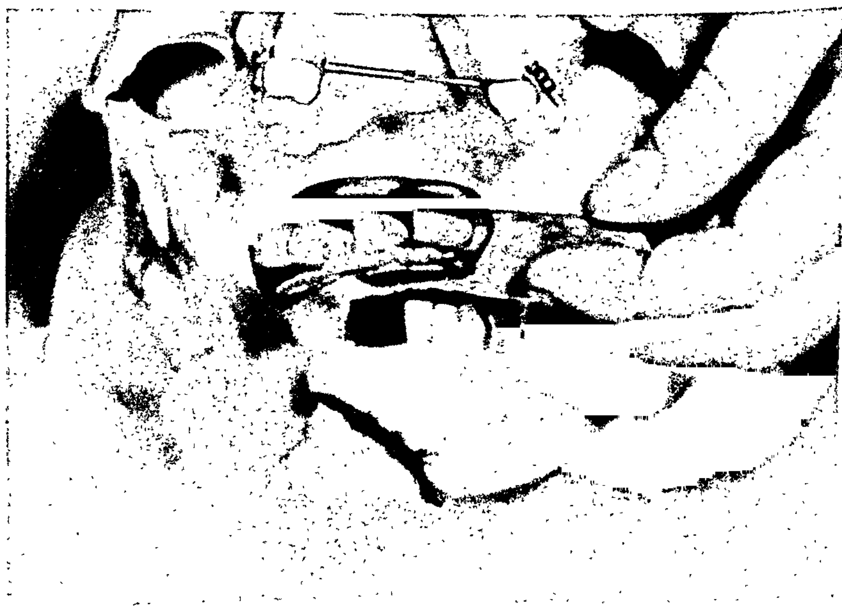


Fig. 146.—Text on page 311.

Figure 147.—The three impressions in dental compound are now ready for the preparation of plaster or stone models; the soft plaster or stone is poured into the impressions.

Figure 148.—The finished plaster or stone models which have been prepared from the impressions in dental compound.

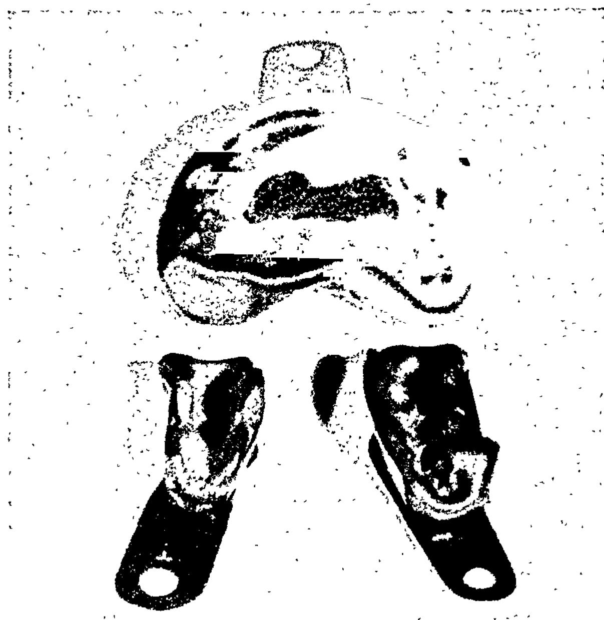


Fig. 147.—Text on page 313.



Fig. 148.—Text on page 313.

Figure 147.—The three impressions in dental compound are now ready for the preparation of plaster or stone models; the soft plaster or stone is poured into the impressions.

Figure 148.—The finished plaster or stone models which have been prepared from the impressions in dental compound.

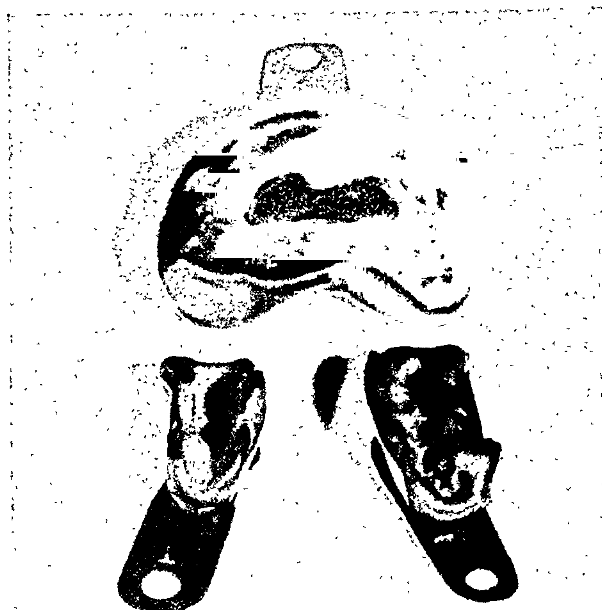


Fig. 147.—Text on page 313.



Fig. 148.—Text on page 313.

Figure 147.—The three impressions in dental compound are now ready for the preparation of plaster or stone models; the soft plaster or stone is poured into the impressions.

Figure 148.—The finished plaster or stone models which have been prepared from the impressions in dental compound.



Fig. 149.—Text on page 315.



Fig. 150.—Text on page 315.

Figure 149.—The vertical downward displacement of the left upper fragment was not corrected by the jackscrew. This displacement can be visualized by observing the oblique position of the wooden applicator which represents the occlusal plane of the upper teeth. If the left upper fragment were not displaced downward, the applicator would assume a horizontal position. This downward displacement of the left upper fragment must be corrected in the stone model.

Figure 150.—In order to correct the downward displacement of the left upper fragment, first the stone model is divided with a saw, as illustrated. Later, the fragments of this model can be realined in correct position.



Fig. 149.—Text on page 315.



Fig. 150.—Text on page 315.

Figure 151.—The fragments of the upper stone model are manipulated until the downward displacement of the left upper fragment has been corrected.

Figure 152.—While the stone fragments of the upper model are held in corrected position, they are joined together with dental sticky wax and small pieces of wood.



Fig. 151.—Text on page 317.



Fig. 152.—Text on page 317.

Figure 153.—The upper stone model is placed upon a mass of clay so that the clay holds the model up under the superior arm of the articulator.

Figure 154.—By means of plaster, the upper stone model is mounted on the upper arm of the dental articulator.

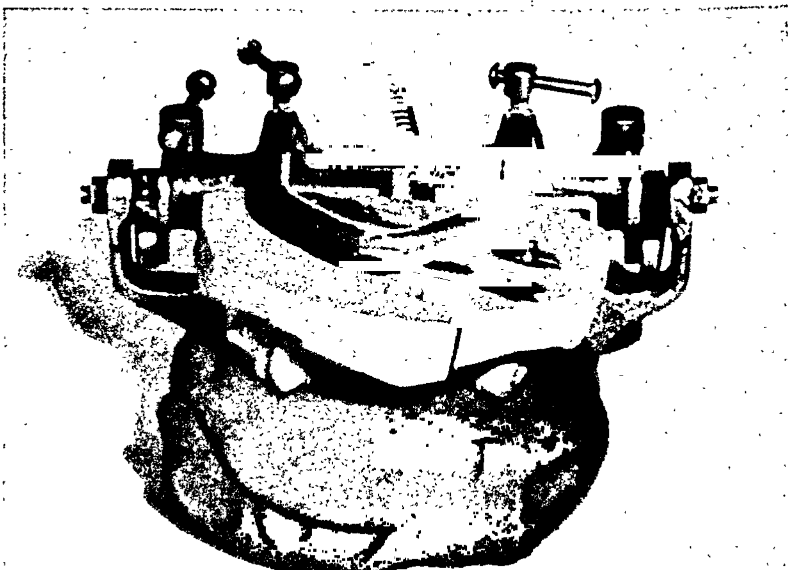


Fig. 153.—Text on page 319.

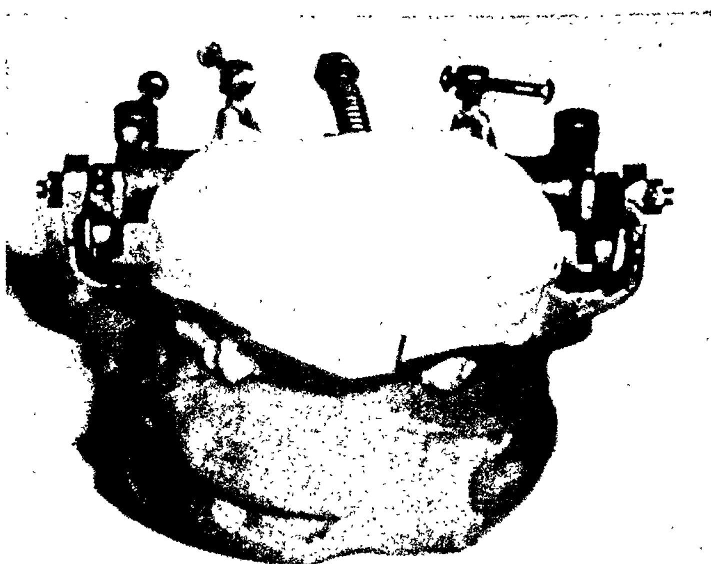


Fig. 154.—Text on page 319.

Figure 155.—The upper stone model which has been mounted on the articulator is turned upside down. The two stone models of the lower teeth then are temporarily attached to the upper stone model by means of sticky wax and small pieces of wood; the upper and lower models are thus joined together in such a manner that the upper and lower teeth occupy positions corresponding to their original occlusion. By means of plaster, the lower stone models are mounted on the lower arm of the dental articulator, after which the sticky wax and pieces of wood, which are holding the upper and lower models together, are removed.

Figure 156.—The upper and lower stone models mounted in proper relationship on the dental articulator.



Fig. 155.—Text on page 321.

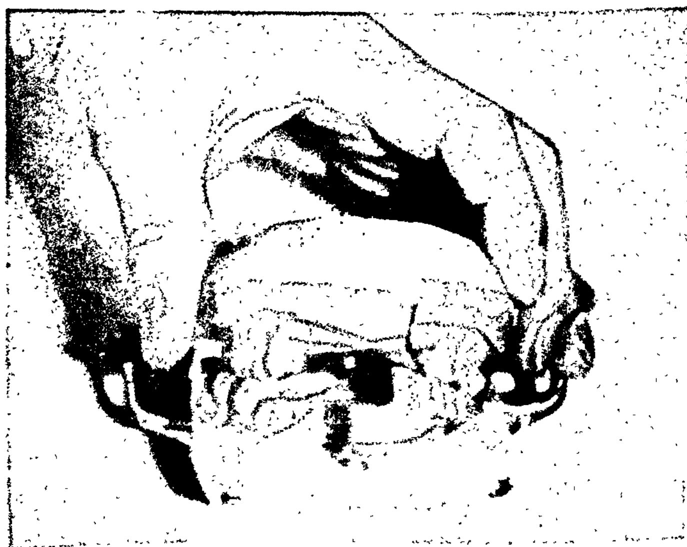


Fig. 156.—Text on page 321.

Figure 157.—The wax pattern for the silver bite splint is now prepared on the stone models which have been mounted in proper relationship. The wax pattern should be so constructed that it is well adapted to the occlusal surfaces of the upper and lower teeth; it should not cover the crowns of the teeth, except on their lingual surfaces. It should fit over these surfaces, as will be apparent in that part of the text which is related to figure 172. Furthermore, the splint should possess multiple perforations all along its outer edge for attachment of various wires.

Figure 158.—The finished wax pattern for the silver splint is removed from the stone models.

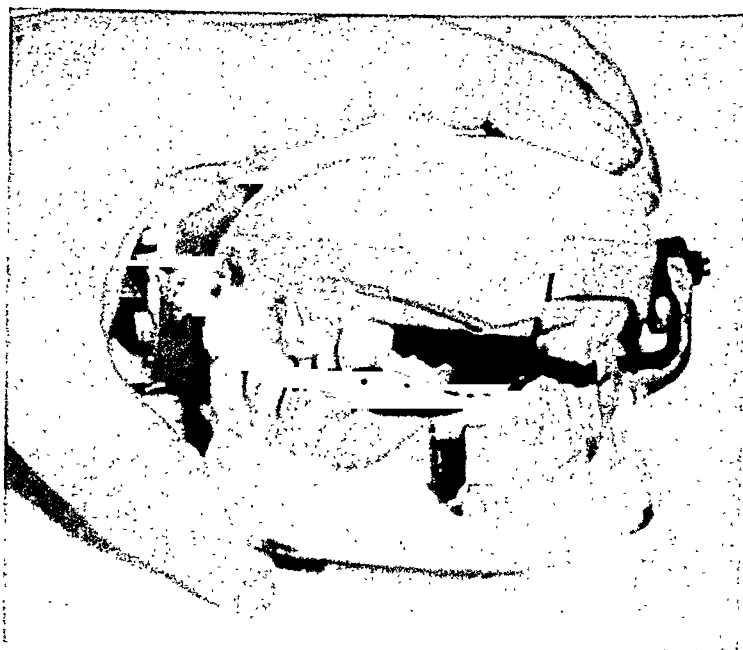


Fig. 157.—Text on page 323.



Fig. 158. Text on page 323.

Figure 159.—The finished silver bite splint has been cast from the wax pattern illustrated in figure 158.

Figure 160.—Preliminary to reduction and immobilization of the facial bones. First, a plaster head cast is constructed; incorporated in this is a metal band possessing three posts to which various appliances can be attached. For details of construction of the plaster head cast see pages 479 to 499.

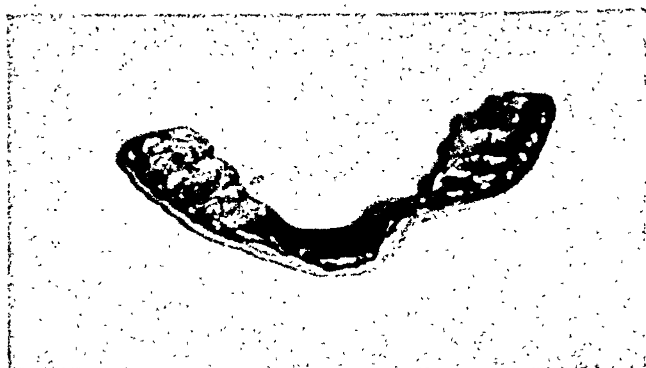


Fig. 159.—Text on page 325.



Fig. 160.—Text on page 325.

Figure 161.—Segments of hooked arch bars are wired to the teeth in the upper fragments. For details sec pages 526 to 528.

Figure 162.—A segment of a hooked arch bar is wired to the teeth of the left lower fragment. Because there are but two molar teeth in the right lower fragment, a hooked arch bar cannot be attached satisfactorily here; instead, an anchor clamp band having a buccal sheath is applied to one of the molar teeth of this fragment. The buccal sheath serves as an excellent attachment for rubber bands or wires.



Fig. 161.—Text on page 327.



Fig. 162. Text on page 327.

Figure 161.—Segments of hooked arch bars are wired to the teeth in the upper fragments. For details see pages 526 to 528.

Figure 162.—A segment of a hooked arch bar is wired to the teeth of the left lower fragment. Because there are but two molar teeth in the right lower fragment, a hooked arch bar cannot be attached satisfactorily here; instead, an anchor clamp band having a buccal sheath is applied to one of the molar teeth of this fragment. The buccal sheath serves as an excellent attachment for rubber bands or wires.



Fig. 163.—Text on page 329.



Fig. 164.—Text on page 329.

Figure 163.—A bar possessing sliding, adjustable hooks and turnbuckles, to which traction wires can be attached for elevation and immobilization of the fragments of the upper jaw, is fastened to the lateral posts of the head band.

Figure 164.—The silver splint is inserted into the mouth.



Fig. 163.—Text on page 329.

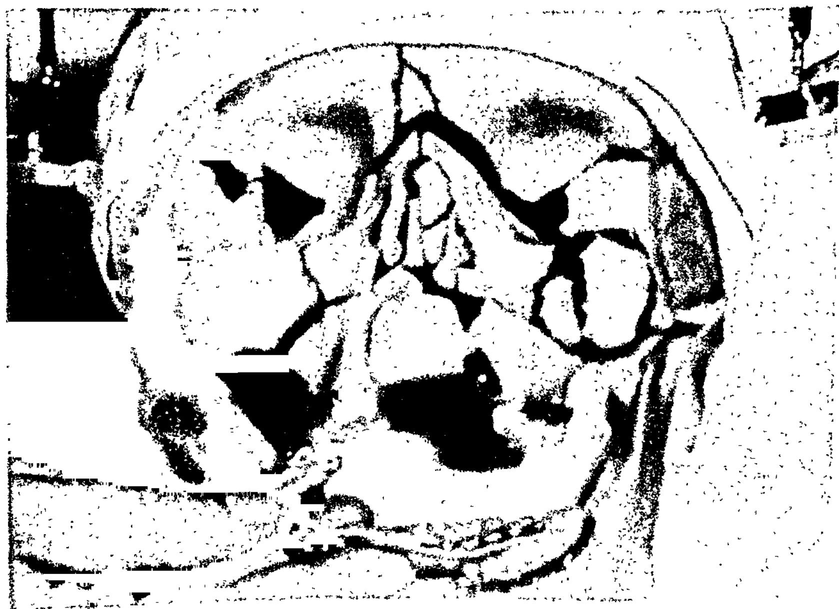


Fig. 164.—Text on page 329.

Figure 165.—The upper fragments are manipulated so that the teeth of these fragments fit as well as possible into the silver splint. On either side, a wire is stretched from the silver splint to the arch bar above. These two wires should be twisted just tight enough to retain the splint and fragments in proper relationship.

Figure 166.—The left traction wire is passed through the cheek by means of a straight needle. See pages 536 to 539. This left traction element consists of a double strand of bronze or stainless steel, 26-gauge wire. Wire of brass or German silver should not be employed for this purpose because these substances irritate the soft tissues and often lead to abscess. The traction wire is inserted into one of the perforations on the outer edge of the silver splint, between the second bicuspid and first molar teeth, and is twisted until it is securely attached to the splint.



Fig. 165.—Text on page 331.



Fig. 166.—Text on page 331.

ʾure 165.—The upper fragments are manipulated so that ːeth of these fragments fit as well as possible into the silver ː. On either side, a wire is stretched from the silver splint e arch bar above. These two wires should be twisted just enough to retain the splint and fragments in proper re- ıship.

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Fig. 165.—Text on page 331.



Fig. [illegible].—Text on page [illegible].

Figure 167.—The upper end of the traction wire is attached to the turnbuckle, which has been unhitched from the adjustable hook on the head cast.

Figure 168.—After attachment of the traction wire to the turnbuckle, there should exist a space of about 1 inch (2.5 cm.) between the upper end of the turnbuckle and the adjustable hook. As is illustrated here, a rubber band is stretched between the turnbuckle and the adjustable hook.



Fig. 167.—Text on page 333.

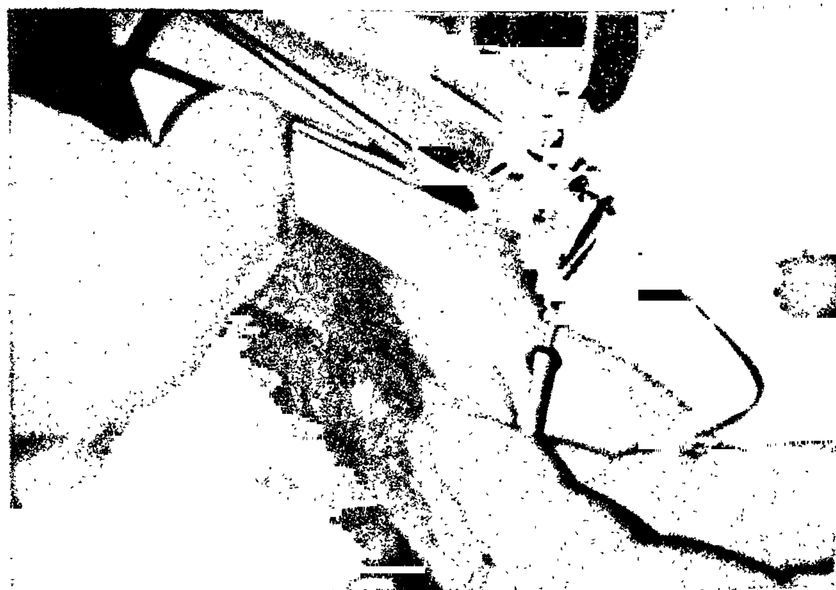


Fig. [illegible].—Text on page [illegible].

Figure 169.—The hook on the head cast is adjusted so that lateral pressure in any direction is not exerted by the traction wire against the soft tissues of the cheek. This adjustment prevents the wire from cutting through the soft tissues to produce a linear scar.

Figure 170.—The right traction wire is applied between the silver splint and the right adjustable hook in a manner similar to that described for the left traction wire. The rubber bands acting on the two traction wires for several hours gradually elevate the silver splint and, in turn, bring the fragments of the upper jaw up into proper position.

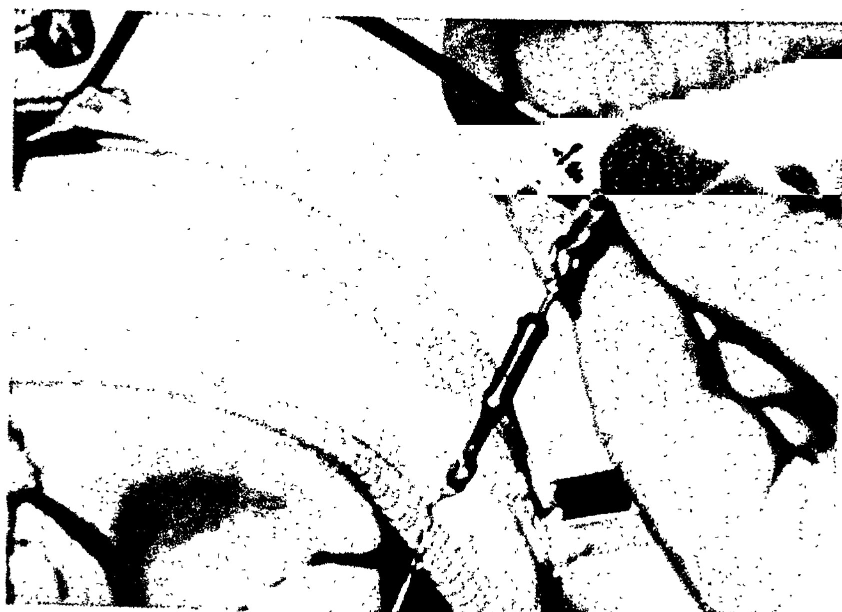


Fig. 169.—Text on page 335.



Fig. 170.—Text on page [illegible].

Figure 171.—The fragments of the upper jaw have been elevated into proper position. Notice how the wide line of fracture over the bridge of the nose in figure 170 has been closed in figure 171 by elevation of the fragments.

Figure 172.—Should the fragments of the maxilla be displaced backward as well as downward, a strong rubber band stretched from the silver splint to a rod that is fixed to the central post of the head band will gradually bring the fragments forward. As was mentioned in the text relating to figure 157, the silver splint should be built to fit over the lingual surfaces of the teeth. This is so that it will not be pulled out of the mouth when strong anterior traction is applied. After the upper jaw has been brought forward to the desired position, the rubber band and rod fixed to the central post of the head cast, illustrated in this figure, can be removed.



Fig. 171.—Text on page 337.

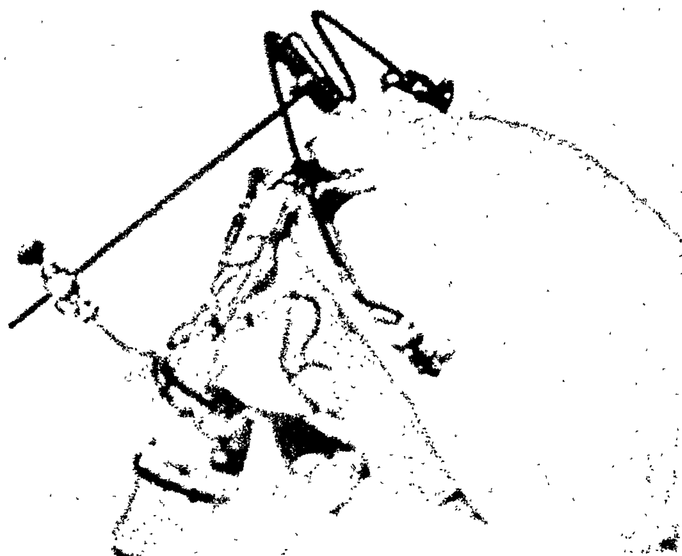


Fig. 172.—Text on page 337.

Figure 171.—The fragments of the upper jaw have been elevated into proper position. Notice how the wide line of fracture over the bridge of the nose in figure 170 has been closed in figure 171 by elevation of the fragments.

Figure 172.—Should the fragments of the maxilla be displaced backward as well as downward, a strong rubber band stretched from the silver splint to a rod that is fixed to the central post of the head band will gradually bring the fragments forward. As was mentioned in the text relating to figure 157, the silver splint should be built to fit over the lingual surfaces of the teeth. This is so that it will not be pulled out of the mouth when strong anterior traction is applied. After the upper jaw has been brought forward to the desired position, the rubber band and rod fixed to the central post of the head cast, illustrated in this figure, can be removed.



Fig. 173.—Text on page 339.



Fig. [illegible]—Text on page [illegible]

Figure 173.—Immediately after application of the traction wires, intermaxillary rubber bands are stretched between the hooks of the upper and lower arch bars to elevate the fragments of the lower jaw into correct alinement with the silver splint. These rubber bands also tend to wedge the upper teeth into correct position with the splint. The rubber bands are in no way connected with the silver splint but merely pass over its outer margin. On the right side, an intermaxillary rubber band is stretched between the upper arch bar and the sheath of the molar band below (see fig. 174).

Figure 174.—The intermaxillary rubber bands have brought the teeth into proper relationship with the silver splint.

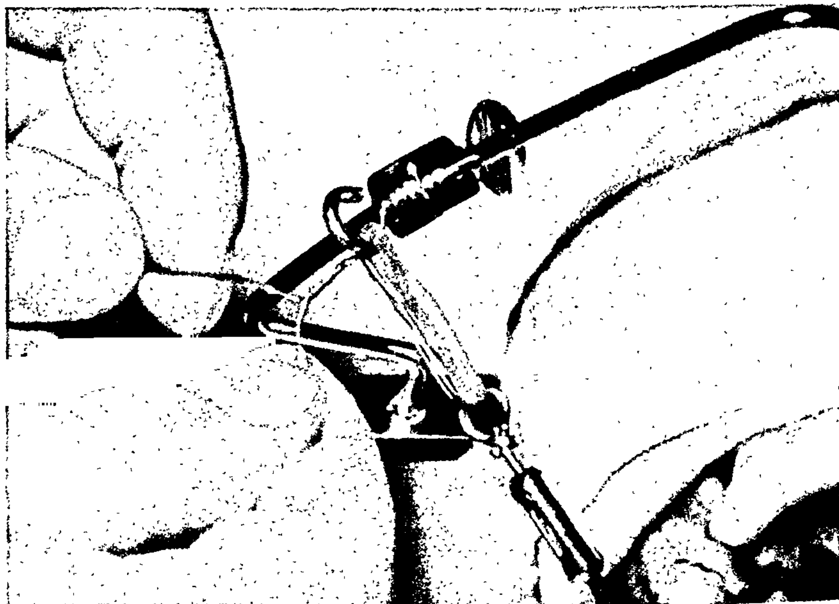


Fig. 175.—Text on page 341.



Fig. 176.—Text on page 341.

Figure 175.—After the fragments of the upper jaw have been elevated to proper position, the rubber bands stretched between the turnbuckle and adjustable hook on either side are replaced with wires. These wires should be applied and tightly twisted before the rubber bands have been removed, to avoid any tendency of the bony fragments to slip downward.

Figure 176.—The turnbuckles offer an effective and easy means of changing the tension on the traction wires whenever desirable.

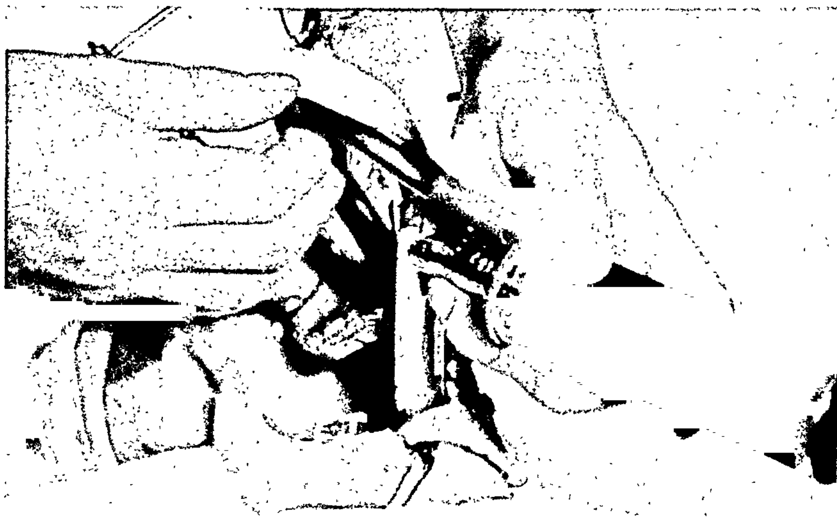


Fig. 177.—Text on page 343.



Fig. 178. Text on page 343.

Figure 177.—Following elevation and immobilization of the fragments of the upper jaw, which usually requires two or three days, treatment of the malar and nasal bones in a single operation can be undertaken. The surgical elevation of malar and nasal bones is extremely painful and necessitates general anesthesia. Because both malar bones must be elevated through incisions within the mouth, there is much bleeding into the mouth and throat. Therefore, such surgical procedures never should be attempted under general anesthesia, with the teeth wired together, for fear that blood may be aspirated into the trachea and bronchi. Consequently, the malar and nasal bones in this situation should be elevated, if possible, under intratracheal gas and ether anesthesia, the intratracheal tube being inserted through the mouth. When the silver splint and traction wires are employed for immobilization of the fragments of the upper jaw, the intermaxillary rubber bands can be removed in order to open the mouth for insertion of an intratracheal anesthesia tube, without disturbing or causing displacement of the immobilized fragments of the maxilla.

As is illustrated here, the intermaxillary rubber bands have been removed and the mouth has been opened. However, the silver splint and traction wires still are immobilizing the fragments of the upper jaw in correct alinement. As is revealed in the illustration, an intratracheal anesthesia tube is being inserted into the trachea through a laryngoscope. Following insertion of the tube, the pharynx is packed off with gauze so that blood cannot enter the trachea.

Figure 178.—After insertion of the intratracheal anesthesia tube, the comminuted left malar bone is elevated. To this end, an incision along the left upper bucco-alveolar fold within the mouth is made. Working through this incision, a blunt elevator or curet is employed to push the soft tissues aside over the anterior aspect of the maxilla. After access to the interior of the left antrum has been gained, the index finger of one hand, or a blunt instrument such as is illustrated in this figure, is introduced into the antrum. Then, with the other hand placed externally, the fragments of the malar bone are manipulated into correct alinement.



Fig. 179.—Text on page 345.



Fig. 180.—Text on page 345.

Figure 179.—A Penrose drain is introduced into the antrum after elevation of the malar fragments; it is placed within the antrum in such a manner that the drain forms a loop, with its two free ends protruding through the incision in the mucous membrane, and into the mouth. This drain permits escape of any purulent material which may form within the antrum after the latter has been packed tightly with gauze.

Figure 180.—Iodoform gauze is packed tightly into the antral cavity for immobilization of the fragments of the malar bone. This gauze should not be removed for three weeks.



Fig. 181.—Text on page 347.



Fig. 182.—Text on page 347.

Figure 181.—The fractured and depressed right malar bone, which is not comminuted, is elevated from within the antrum. Were it not for the fact that two and a half weeks have elapsed since the injury, it could be elevated with a hook. This malar bone is elevated in a manner similar to that described for the left malar bone. This illustration shows a blunt instrument within the right antrum, elevating the malar bone while one hand is employed externally for manipulation of the bone.

Figure 182.—A Penrose drain and iodoform gauze pack are introduced into the right antral cavity in a manner similar to that described for the left malar bone. The gauze pack immobilizes the right malar bone for three weeks.



Fig. 183.—Text on page 349.



Fig. 184.—Text on page 349.

Figure 183.—Immediately following surgical treatment for the malar bones, the nasal bones, which are comminuted and depressed, are elevated. As illustrated, a blunt instrument is introduced high within the left nasal cavity for elevation of the fragments of the left nasal bone. One hand is employed externally to manipulate and mold the elevated fragments into correct alinement.

Figure 184.—The fragments of the right nasal bone are elevated in a manner similar to that described in the legend of figure 183.



Fig. 183.—Text on page 349.



Fig. 184.—Text on page 349.

Figure 185.—Blunt instruments are introduced into each nostril and are employed forcibly to straighten the fractured nasal septum. Due to the comminution of the nasal septum, which is usually present in a case of this type, such manipulation of the septal fragments usually is rather ineffective.

Figure 186.—Because of the comminution of the nasal septum, there is no remaining support for the fragments of the nasal bones. Consequently, some external form of fixation is required after reduction of the fractures of the nasal bones. As illustrated, our appliance for holding the nasal bones forward in the desired position is being inserted into the nose. It possesses two wires, each covered with a rubber catheter, which are introduced high into each nasal cavity. By adjustment of the various thumb set screws on this appliance, these wires are made to elevate and immobilize the nasal bones in a desirable forward position. The entire appliance is fixed to the central post on the head cast and should be maintained in position for two weeks. After this time, sufficient fibrous tissue has formed to hold the fragments of the nasal bones in the desired position.



Fig. 185.—Text on page 351.

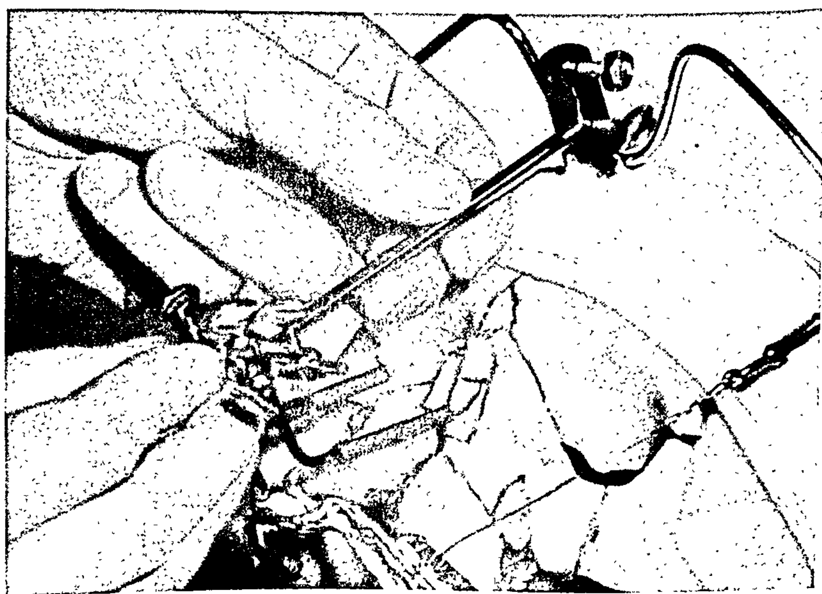


Fig. 186.—Text on page 351.

Figure 187.—The nasal appliance is being inserted. When it is finally adjusted, the nasal bones will be held forward in normal position.

Figure 188.—Following elevation of both malar bones and the nasal bones, and following adjustment of the nasal appliance, the intratracheal anesthesia tube is removed. For a few hours after these operations, the patient may go through a stage of nausea and vomiting due to the anesthetic agent. During this period, the mouth should be left open so that none of the vomitus will be aspirated into the trachea. As soon as the patient is no longer nauseated, the intermaxillary rubber bands are reapplied, as is illustrated in this figure, to bring the teeth of the lower jaw back into proper position with the silver splint.

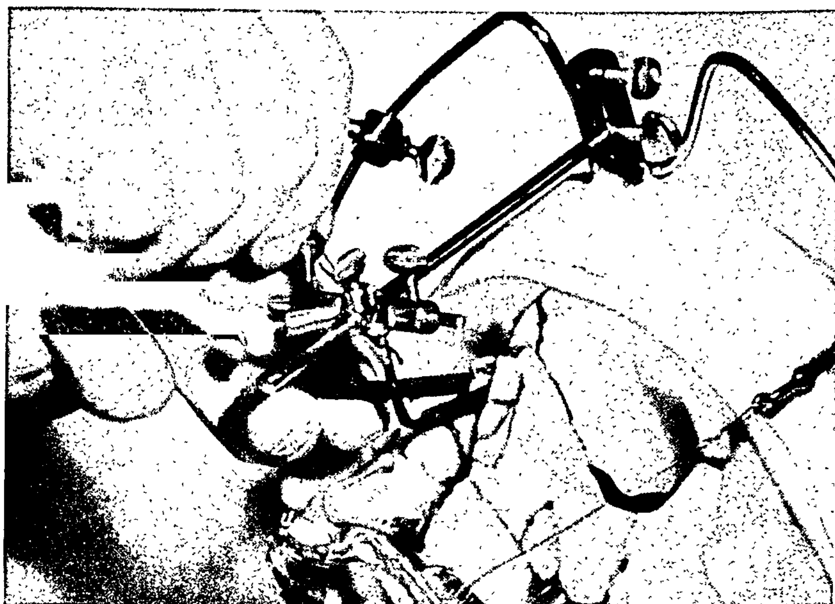


Fig. 187.—Text on page 353.

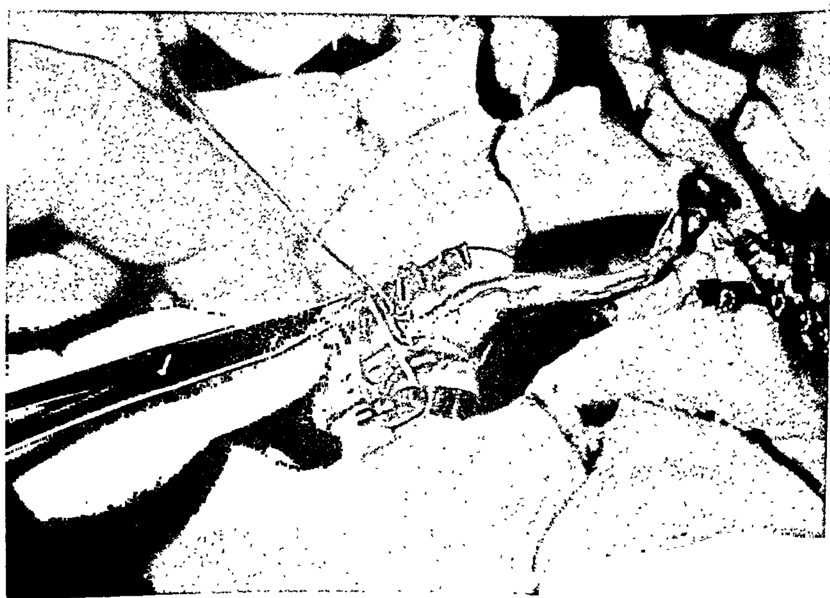


Fig. 188.—Text on page 353.

Figure 189.—If the loose fragment of bone in the anterior part of the mandible cannot be brought up into proper position manually, elastic traction applied to a felt chin sling becomes necessary. If thick felt is employed for this purpose, it will not irritate the skin in the submaxillary region as do many other materials. The rubber bands are stretched between the chin sling and hooks attached to strips of adhesive tape that are stuck to the plaster head cast. This chin sling need be left in position only for about one week.

Figure 190.—Two weeks after elevation of the nasal bones (about four and a half weeks after the injury), the nasal appliance used for the purpose is removed. As was discussed in chapter V, this nasal apparatus tends to widen the bridge of the nose and must be replaced by a second appliance which has adjustable lateral pads for narrowing the nasal bridge. This illustration reveals the second nasal appliance being attached to the central post on the head cast.

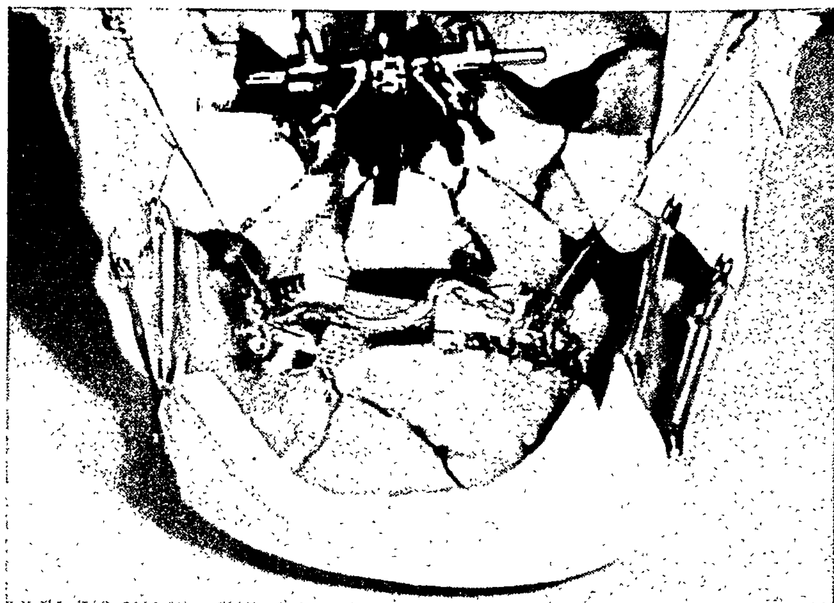


Fig. 189.—Text on page 355.

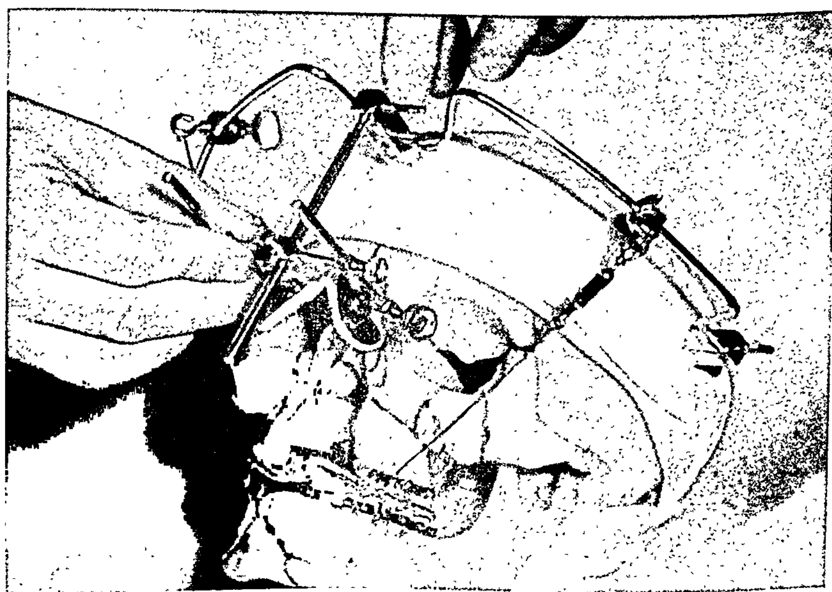


Fig. 190.—Text on page 355.

Figure 191.—The second nasal appliance is in position. The lateral pads may be screwed down to narrow the nasal bridge to any desired degree; this is best accomplished by giving the screw to each pad a few turns daily for two or three days. This second nasal appliance should be left in position for approximately two weeks.

Figure 192.—Three weeks after immobilization of the fragments of the upper jaw and of the malar bones (five and a half weeks after the injury), sufficient healing has occurred to permit removal of the iodoform packs, Penrose drains and traction wires.

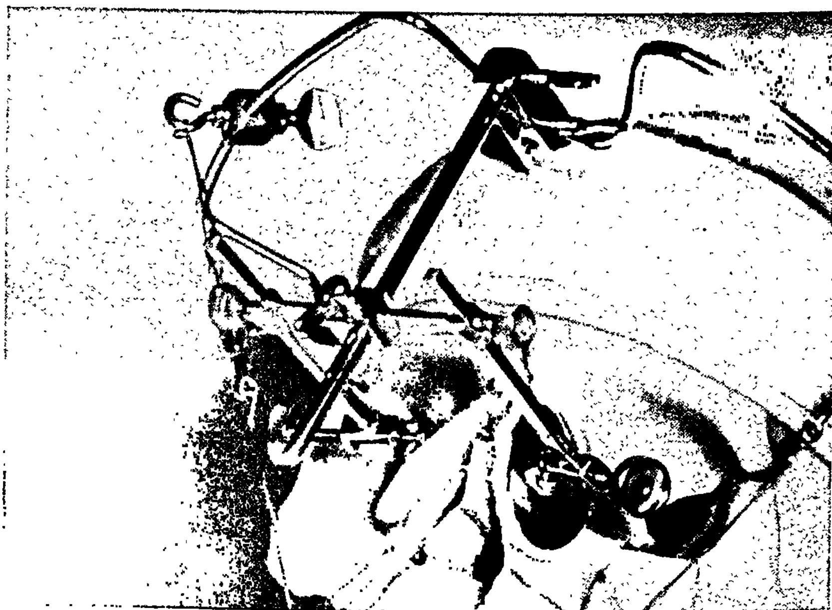


Fig. 191.—Text on page 357.

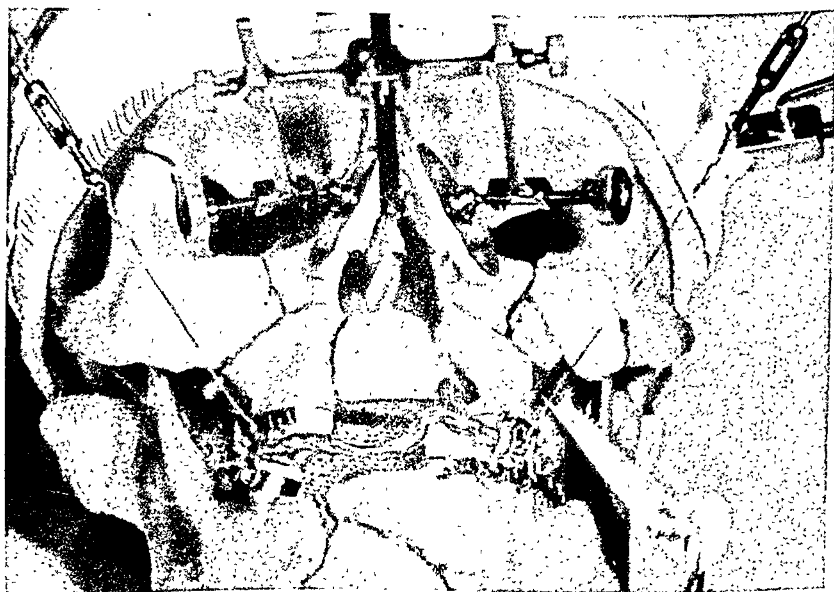


Fig. 192.—Text on page 357.

Figure 193.—At this stage, the silver splint also may be removed.

Figure 194.—After removal of the silver splint, the intermaxillary rubber bands are re-applied to the hooked arch bars in an attempt to overcome any defects in proper dental occlusion. It is reasonable to assume that the plaster models on which the wax pattern for the silver splint was constructed cannot be mounted on the articulator so as to duplicate precisely the patient's original bite. Consequently, the silver splint does not represent an exact counterpart of the patient's bite prior to the injury. The resultant discrepancies in occlusion, while of no great significance, do become apparent on removal of the silver splint. However, these imperfections in dental occlusion at this stage still can be corrected by re-application of strong intermaxillary elastic bands.



Fig. 193.—Text on page 359.



Fig. 194.—Text on page 359.

Figure 195.—Nothing need be done about the right subcondylar fracture. Although the condyle is displaced, it will not interfere with function of the mandible.

Figure 196.—After being in position for two weeks (six and a half weeks after the injury), the second nasal appliance is removed. The head cast also may be discarded at this time.

Two weeks after the silver splint is removed (seven and a half weeks after the injury), the intermaxillary rubber bands and arch bars are removed.

The model of the skull following treatment of the fractured facial bones (seven and a half weeks after the injury), is illustrated herewith. All of the bony fragments have been replaced with the exception of the right condyle. See the frontispiece and figure 137 for the condition immediately after the fracture.

Note: In problem 42 it is assumed that fractures of the palate exist with displacement of the palatal fragments. Should no displacement of the palatal fragments be present, then treatment should follow the plan outlined in problem 40 of chapter VI.



Fig. 195.—Text on page 361.



Fig. 196.—Text on page 361.

CHAPTER VIII

DEFECTS OF THE MANDIBLE WHICH REQUIRE A BONE GRAFT

TRAUMATIC loss of a portion of the mandible, whether it is due to the primary injury, such as a bullet or shrapnel wound, or whether it is due to secondary infection, may call for transplantation of bone to re-establish continuity of the lower jaw. Such a procedure restores function and often, incidentally, improves symmetry of facial contour. The possibility or lack of possibility of restoring function should be the deciding factor in determining whether or not a bone graft is indicated in any case. Despite the refinements of surgical technic which have been developed in recent years, failures in bone grafting still occur. This fact should discourage indiscriminate use of transplants of bone to correct every ununited fracture or bony defect of the mandible. Only when loss of bone actually interferes with dental occlusion and masticatory function, is there a legitimate indication for use of a bone graft to the mandible. Even though continuity of the mandible may have been interrupted by loss of bone, as is illustrated in figure 197, if the teeth are in good occlusion and if function of the jaw is normal, a bone graft never should be considered. Too frequently, as has just been indicated, bone grafts are unsuccessful. Conesquently we would like to stress again the fact that surgical transplantation of bone to the mandible should be reserved entirely for correction of bony defects which interfere with function of the jaws.

There can be no doubt that much of the success of maxillary bone grafting depends on painstaking aseptic surgical technic and on construction of dental and other mechanical appliances which will maintain adequate immobilization of the bony fragments during the period of healing. However, absolutely aseptic technic and perfect fixation do not always insure success. Other



factors are sometimes present which ultimately lead to discouraging results. Unfortunately, these factors too frequently can be neither discovered before operation nor coped with satisfactorily after operation.

CAUSES OF FAILURE OF BONE GRAFTS

Study of the causes which contribute to failures in bone grafting requires, first, appreciation of the biologic and physiologic processes concerned in regeneration and repair of bone. Experiments conducted by many research workers seem to indicate that all, or at least the greater portion, of a bone graft undergoes gradual death. However, as the implant dies, new bone is formed to replace the dying bone. Shortly after transplantation, the graft becomes enveloped in a vascular form of fibrous tissue supplied by the bed in which the graft is placed. Excavations soon occur on the external surfaces of the implant and, as the vascular tissue penetrates into the haversian canals, a similar slow, destructive process occurs in the haversian system. Simultaneously with the foregoing activities, osteoblasts make their appearance on the surface and in the bony canals of the graft, and promptly begin to produce new bone. It is thought that physiochemical substances released by the disintegrating transplant stimulate the formation of new osseous tissue.

Much controversy exists as to the origin of the osteoblasts. Some authors believe that they are derived from the periosteum and endosteum of the graft, as well as from the ends of the bony fragments. Others take exception to this hypothesis and believe that all osteoblasts transplanted with the graft die; it is their opinion that, while some of the osteogenic cells which produce new bone in and about the graft are derived from the injured ends of the mandible, the greater number arise as the result of metaplasia of undifferentiated connective tissue cells enveloping the graft. Although at present there is no way of determining the origin of these bone forming cells, the problem is not without clinical significance, as will be pointed out later.

To sum up the physiologic processes which occur in transplantation of bone, it might be said simply that the graft is destroyed gradually and more or less completely and is replaced by newly formed bone which fuses with the ends of the bony

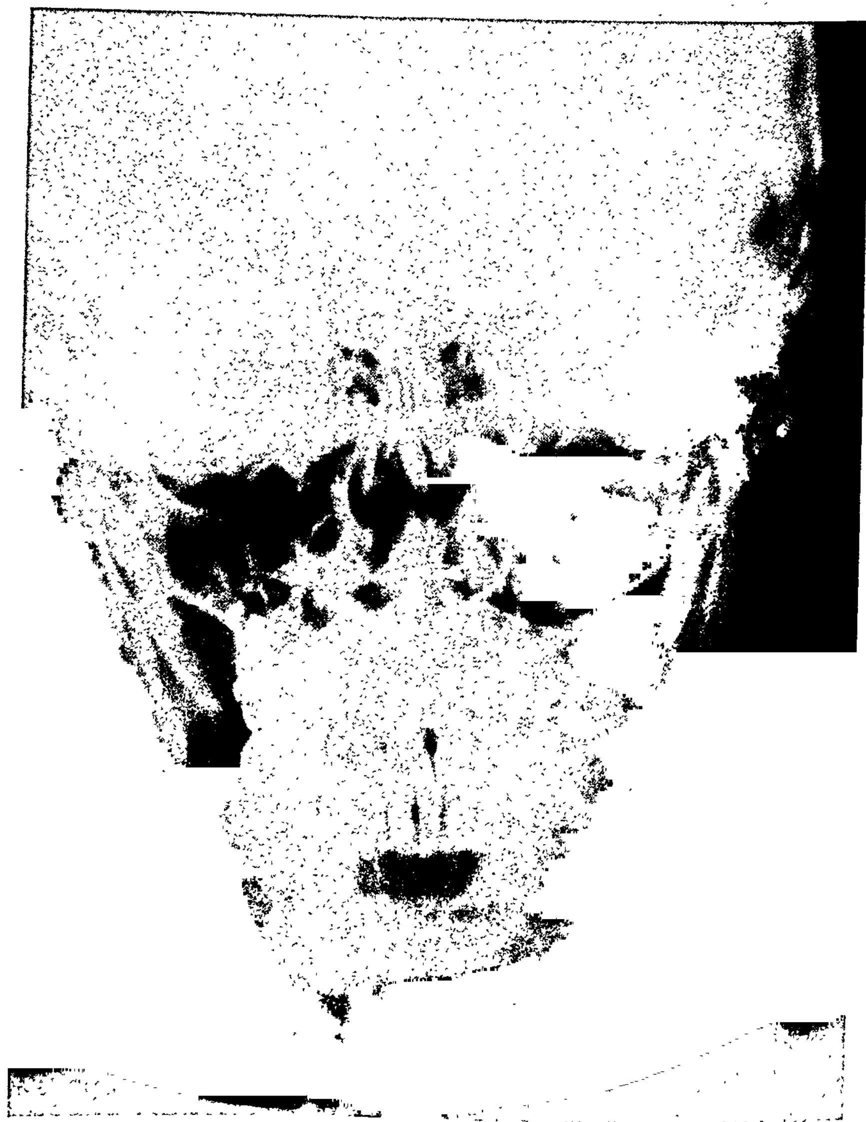


Fig. 197.—Bone was lost from the region of the right angle of the mandible. Dental occlusion was perfect and function of the jaw was normal. Consequently there was no indication for use of a bone graft. Text on page 363.

An infrequent but definite cause for failure of bone grafting is the presence of extremely dense, avascular scar tissue intervening between, and surrounding, the ends of the bony fragments. Here, the blood supply is so poor that not only is adequate vascularization of the graft impossible but the production of osteogenic cells is markedly inhibited. Under these circumstances, a bone graft is likely to undergo rapid death and sequestration.

Another etiologic factor responsible for failure in bone grafting is lack, in some cases, of the necessary physiochemical and cellular reactions which are essential to the physiologic destruction and regeneration of the graft. Fortunately, this cause of failure in transplantation of bone is rare.

fragments. The rapidity with which this phenomenon of des
tion and substitution occurs depends to a large extent on
density of the transplant; the denser the bone of the transp
the more slowly will it undergo disintegration and be repla

In most instances, failures of bone grafting are the resu
infection. The presence of pathogenic bacteria is likely to
duce rapid destruction not only of the cellular elements of
graft, but also of the osteogenic cells so essential to forma
of new bone. In consequence, the implant becomes a sor
foreign body which ultimately is extruded. From a clinical st
point, familiarity with the etiologic factors that favor the de
opment of infection about bone grafts is essential. It is alw
possible, of course, to carry pathogenic bacteria into the wo
by improper sterilization of instruments or by faulty surg
technic. However, the most frequent cause of infection undo
edly is a nick or a tear through the oral mucous membr
accidentally produced during the operative procedure. E
though such a perforation may be otherwise extremely insig
cant, it affords a portal through which secretions from the mo
can enter and contaminate the wound.

Unfortunately, the source of some infections about bone gr
is not so obvious. Bacteria which invade the wound at the ti
of the original injury may lie dormant in the tissues for ma
weeks without being destroyed and without causing any clini
evidence of infection. But on the introduction of a bone gr
into the region, the subsequent inflammatory reaction app
ently stimulates these organisms to produce an acute infecti
process. A latent infection, then, is a constant potential dan
in bone grafting. It is imperative, therefore, that sufficient ti
elapse between the occurrence of the bony defect and the bo
grafting operation for the tissues to become free of all pathoge
organisms. Just how long the period between these two eve
should be is a matter of conjecture. It is our opinion that t
insertion of a bone transplant to correct a mandibular bony d
fect of traumatic origin is best deferred for three or more mont
following the injury. If the loss of bone is due to necrosis
osteomyelitis, the patient then should be entirely free of sym
toms or signs (swelling, discharge, pain or sequestra) for six
nine months before implantation of a bone graft. While som
what arbitrary, these time intervals in general are adequate.

An infrequent but definite cause for failure of bone grafting is the presence of extremely dense, avascular scar tissue intervening between, and surrounding, the ends of the bony fragments. Here, the blood supply is so poor that not only is adequate vascularization of the graft impossible but the production of osteogenic cells is markedly inhibited. Under these circumstances, a bone graft is likely to undergo rapid death and sequestration.

Another etiologic factor responsible for failure in bone grafting is lack, in some cases, of the necessary physiochemical and cellular reactions which are essential to the physiologic destruction and regeneration of the graft. Fortunately, this cause of failure in transplantation of bone is rare.



Fig. 198.—Text on page 369.

GENERAL CONSIDERATIONS IN THE USE OF BONE GRAFTS TO THE MANDIBLE

Preparations for the use of a bone graft to correct a bony defect of the mandible should be started at the time of the injury rather than several weeks or months later. In so doing, much time is saved and a more desirable result is assured.

In many instances, the character of the wound suggests at the time of the injury that a bone graft eventually will be required to re-establish the continuity of the mandible (fig. 198). If, at this time, teeth which are hopelessly damaged and teeth which will interfere with proper attachment of the bone graft are extracted, a great deal of time will be spared later on in the course of treatment. Removal of loose pieces of bone which are certain to undergo sequestration, and insertion of through-and-through Penrose drains, as was described in chapter II, Problem 23, prevent the occurrence, or at least prevent the extension, of suppurative infections to healthy bone. Furthermore, if mechanical intra-oral appliances are employed shortly after the injury to maintain the fragments in proper position, this will prevent subsequent displacement of the fragments and of the teeth, thereby increasing the ease with which the bone grafting operation can be performed and, more particularly, the effectiveness of the ultimate result.

To facilitate the following discussion as well as the therapeutic management of a patient who is to have a bone graft to the mandible, we believe it is advisable to divide the treatment, from the time of the injury until the time when healing of the bone graft has become complete, into three parts:

Part I. Treatment from the time of the injury until the time when the bone graft can be safely inserted, a matter of three to nine months.

1. Extraction of teeth which are hopelessly damaged or which will interfere with application of a bone graft.
2. Fixation of the fragments of the mandible in normal position during the preoperative period.

Part II. Fixation of the bony fragments of the mandible for immobilization of the bone graft.

Part III. Details of technic necessary in transplantation of bone to the mandible.

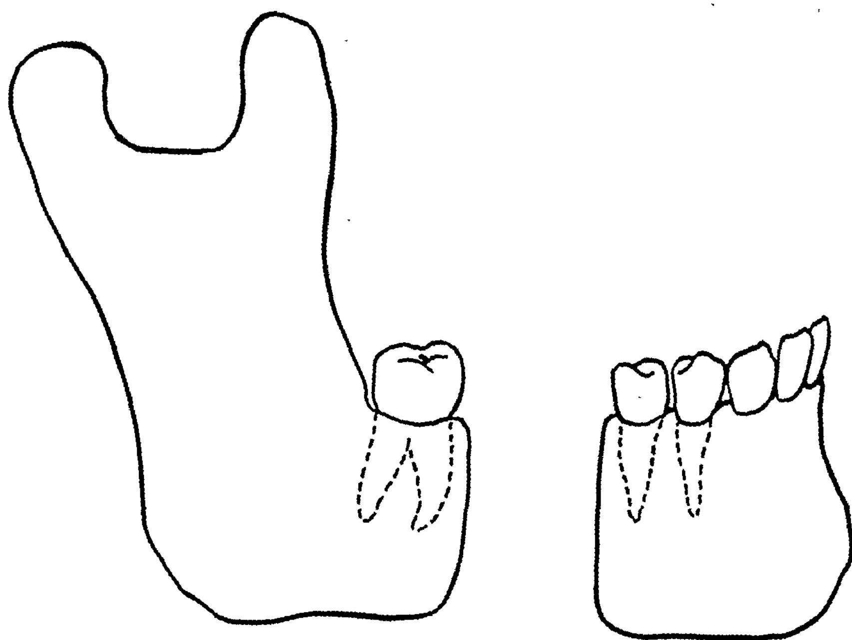


Fig. 199.—Text on page 371.

PART I

TREATMENT FROM THE TIME OF THE INJURY UNTIL THE TIME WHEN THE BONE GRAFT CAN BE SAFELY INSERTED, A MATTER OF THREE TO NINE MONTHS

Subdivision 1

Extraction of Teeth Which Are Hopelessly Damaged or Which Will Interfere with Application of a Bone Graft to the Mandible (Figs. 199 to 202 Inclusive)

Long before proceeding with transplantation of bone to the mandible, it is essential that all teeth the roots of which are located near the ends of the fragments, and all teeth that are hopelessly damaged, be extracted. Removal of all such teeth should be carried out at least three months prior to insertion of the transplant. In fact, it is desirable to extract such teeth as soon as possible after the original injury, and preferably before a splint is constructed for fixation of the bony fragments.

If, in the preparation of the end of a fragment for reception of a bone graft, a dental root is exposed, necrosis of pulp and formation of abscess are almost certain to ensue; the result of such suppuration is death and extrusion of the implant. Consequently, in order to prevent this complication, we believe that at least 2 cm. of bone beyond the free edge of each fragment should be devoid of teeth. There is but one exception to this rule: If a tooth situated near the end of a fragment is the only means of fixation for that part of the mandible, it should be retained. Under these circumstances, the two bicuspids represented in figure 199 should be extracted, while the molar teeth in the posterior fragment should be retained.

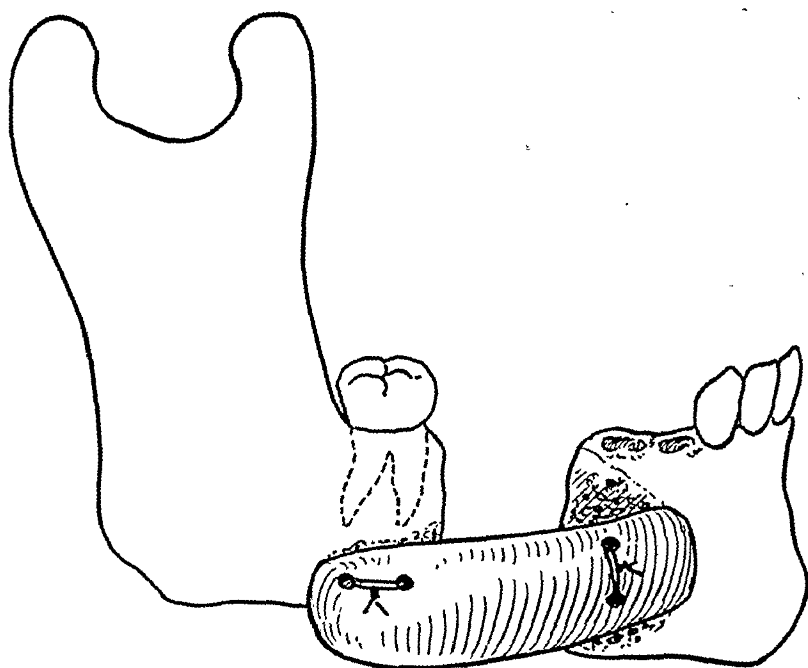


Fig. 200.—Text on page 373.

When a tooth of which the roots are situated close to the end of a fragment is retained, however, the bone graft must be attached in a manner differing from the usual procedure (fig. 200). We prefer to attach the bone graft in a position lower on the mandible than that portion of it which surrounds the roots (figs. 200 and 201). If this is done, the graft has a broader surface of attachment than otherwise it would have, but also it may protrude conspicuously below the lower border of the mandible. This projecting portion of the graft we do not attempt to remove. As is shown in figure 202, all of this excess bone is absorbed gradually and the ultimate contour of the mandible is essentially normal. One of the surprising physiologic processes which occur in bone grafting is the absorption of excess bone and the building up of the graft in regions subjected to the greatest amount of stress and strain.



Fig. 201.—Dr. G. B. New's case. The bone graft is attached to the posterior fragment below the molar tooth, which was saved for fixation of this fragment. Text on page 373.



Fig. 202.—Roentgenogram in same case represented in figure 201, but two years later. The bone that projected along the lower border of the mandible has become absorbed and bone is building up between the fragments. Text on page 373.



Fig. 203.—Text on page 377.

Subdivision 2

Fixation of the Fragments of the Mandible in Normal Position during the Preoperative Period (Fig. 203)

During the interval of waiting between the time when a portion of the mandible is lost and the time when it is safe to proceed with insertion of a bone graft, scar tissue forming between the fragments gradually pulls them together and disturbs their entire relation to the upper jaw (fig. 203). Moreover, the teeth themselves tend to shift; this displacement often becomes so marked that the former occlusion between the upper and lower teeth never can be restored. Shortly after the original injury it is desirable, therefore, to construct for each individual an appliance which will maintain the fragments in normal position. What type of mechanism should be constructed depends entirely on the number of teeth present in each fragment.

If the fragments of a mandible in which there is a bony defect are not immobilized by some form of splint, and are permitted to be drawn together by scar tissue, this scar must be incised to permit replacement of the fragments in their original relation to the upper jaw. This is particularly important in cases in which teeth are present in one or both fragments. Ordinarily, we incise the intervening scar tissue by means of a scalpel or scissors, cutting first through the oral mucous membrane and carrying the incision down across the dense scar below. When completely free, the two fragments can be manipulated into their former position and stabilized by one of the splints to be described. Following such a procedure, the problem of infection of tissue again arises, necessitating deferment of a bone grafting operation for at least three months.

Based on the number of teeth present in each fragment, there are five problems in fixation of the bony fragments to be considered. These five problems are discussed on pages 378 to 392.



Fig. 204.—Text on page 379.

Fixation for the Fragments of a Mandible in Both of Which Several Teeth Are Present (Figs. 204, 205 and 206)

When each fragment contains several teeth, a sectional hinged splint made of one of the acrylic compounds or silver (we prefer the latter) is ideal (fig. 204). Such a splint consists of three sections hinged together posteriorly by half round wires (fig. 205). When it has been placed about the teeth, the buccal segments are held together by a wire passed around a divided button (fig. 206). This appliance depends for retention, not on cement, but on its grip in the interdental spaces and, since it does not cover the occlusal surfaces of the teeth, there is no interference with occlusion. Finally, such a splint can be removed easily at frequent intervals for cleansing of the teeth and it maintains the fragments in perfect position for any desired length of time. This splint requires a hydrocolloidal (dentocol) impression and the details of its construction are described on pages 565 and 567.

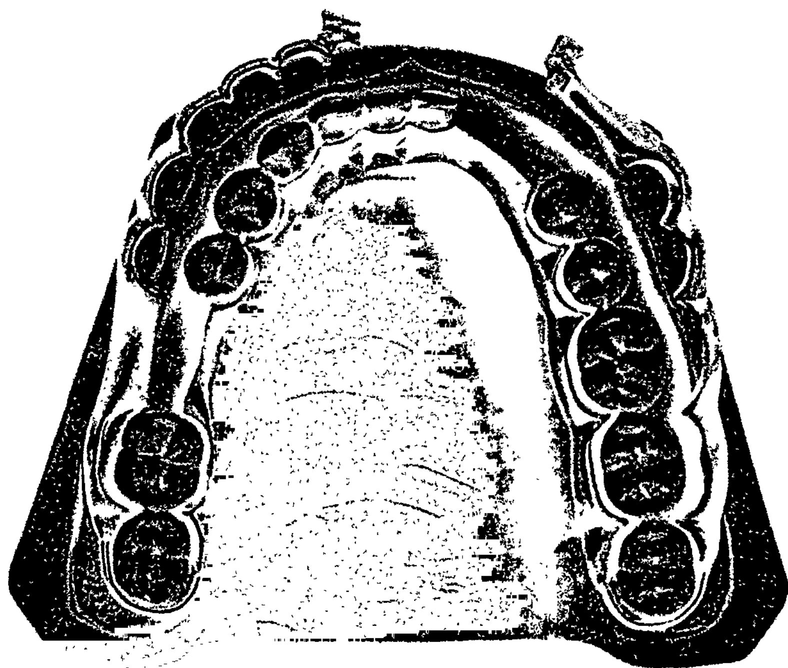


Fig. 205.—Text on page 379.

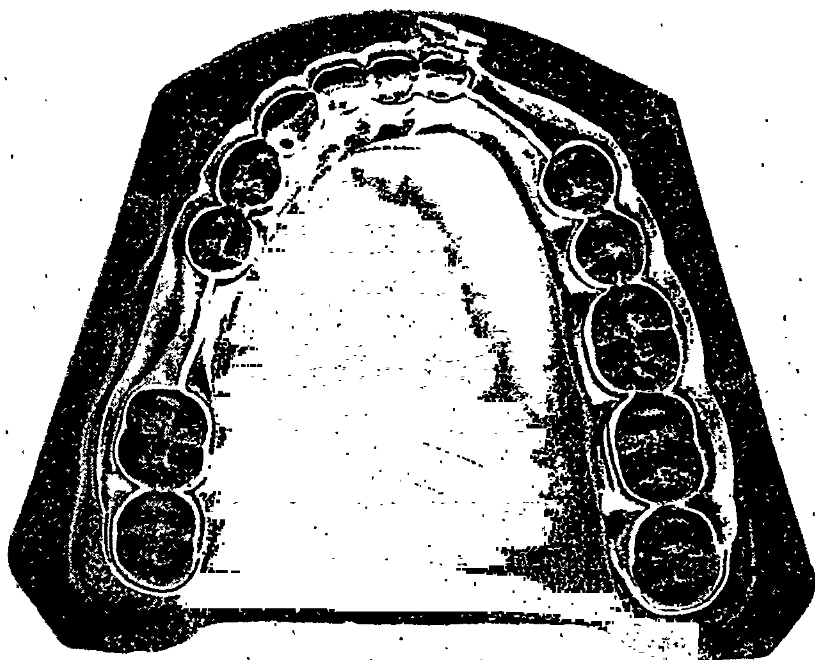


Fig. 206.—Text on page 379.

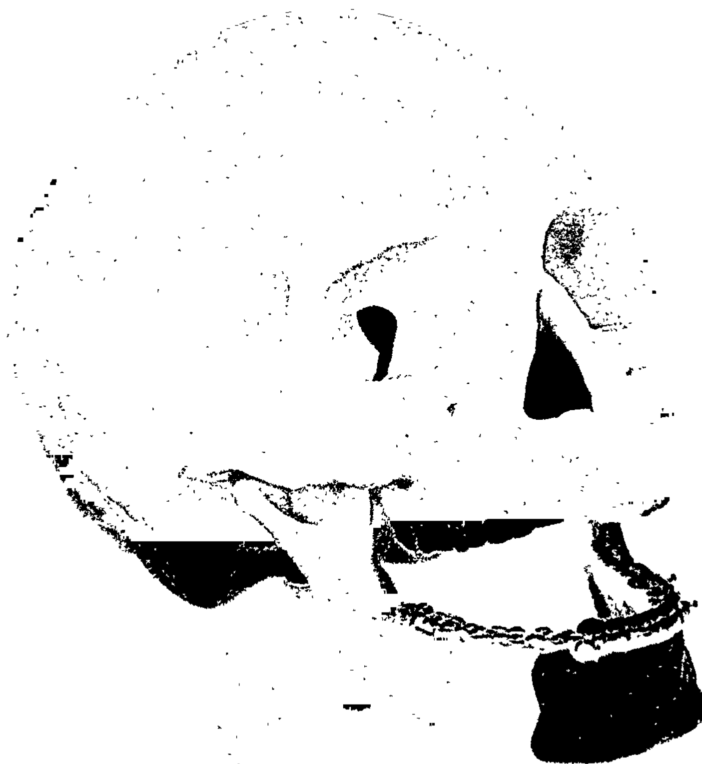


Fig. 207.—Text on page 383.

Fixation When Several Teeth Are Present in the Long Anterior Mandibular Fragment and Only One Tooth in the Short Posterior Fragment (Figs. 207, 208 and 209)

If there is but one molar tooth in a short posterior mandibular fragment it is inadvisable to use the type of splint represented in figure 204, since it does not afford sufficient stabilization for the two fragments. Under these circumstances, one of us (JBE) has devised a divided, hinged splint made of cast silver (figs. 207 and 208); this is attached around the teeth of the long anterior fragment and spans the edentulous region from which bone has been lost. Attached to the molar tooth in the short posterior fragment is an orthodontic molar band which when screwed down cannot be displaced. The cast silver splint and molar band are then connected by a rod which is wired securely to lateral loops on the former and which fits into the buccal sheath of the latter (fig. 209). This arrangement of splint, molar band and connecting rod supplies perfect fixation of the fragments. For details of construction of the splint see page 571.

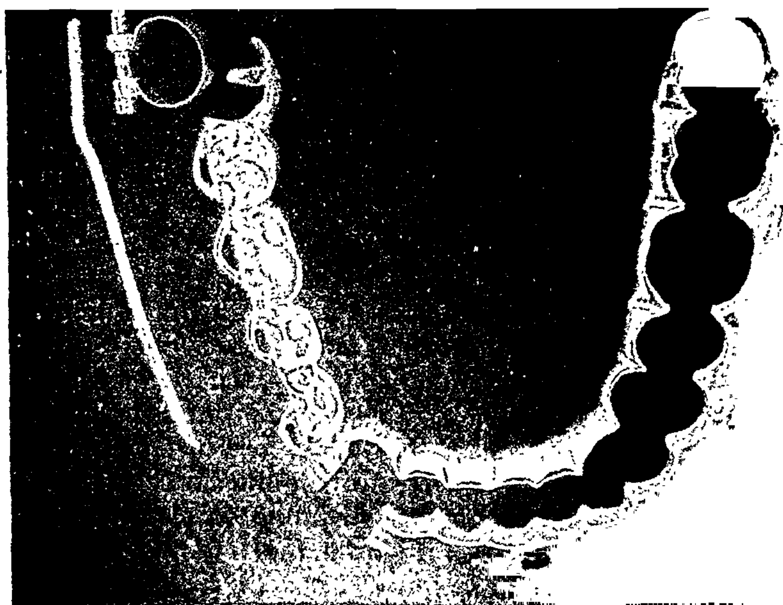


Fig. 208.—Text on page 383.

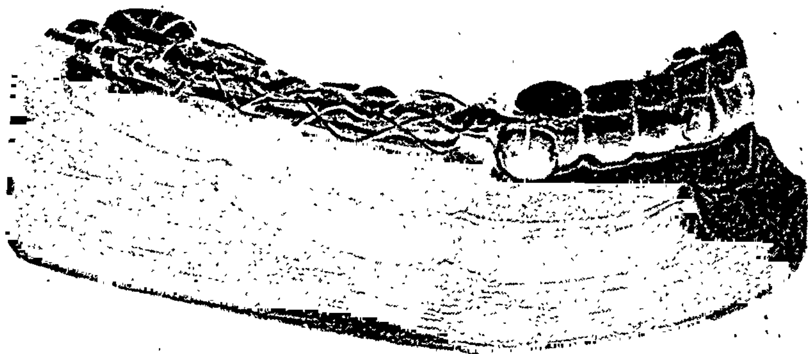


Fig. 209.—Text on page 383.

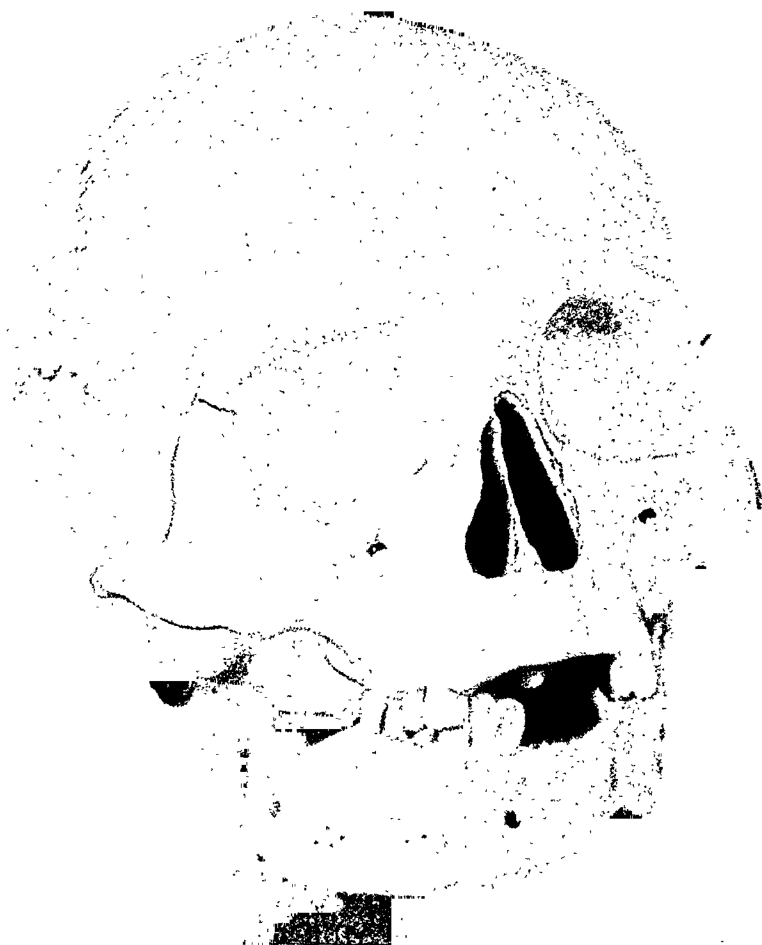


Fig. 210.—Text on page 387.

Maintaining Proper Dental Occlusion When One Entire Ramus of the Mandible Is Lost (Figs. 210, 211 and 212)

When one ramus of the mandible is lost, the remaining portion will be markedly pulled to the side where the loss occurred, if no device is used to keep this portion in its original position (fig. 210). Moreover, if the fragment is allowed to become displaced, the teeth tend to shift so badly that the original occlusion never can be restored, even though the malposition of the mandible is corrected. Consequently, it is of great importance to construct an appliance shortly after the injury which will maintain the fragment in normal position and, in turn, maintain normal occlusion of the remaining teeth.

The splint which we recommend for this purpose is cast of silver and possesses a buccal flange (fig. 211). This splint is cemented to the teeth in the bicuspid and molar regions of the remaining portion of the mandible (fig. 212). As the patient opens and closes his mouth, the flange rides on the buccal surface of the opposing upper teeth and prevents the mandible from being drawn to the opposite side. For details of construction of the splint, see page 583.

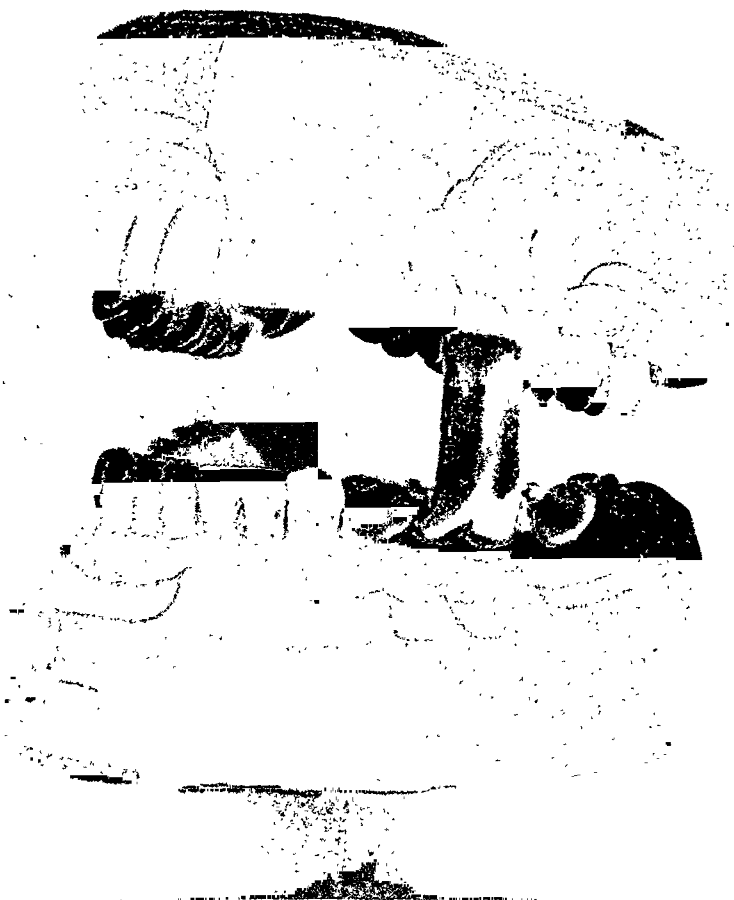


Fig. 211. Text on page 387.

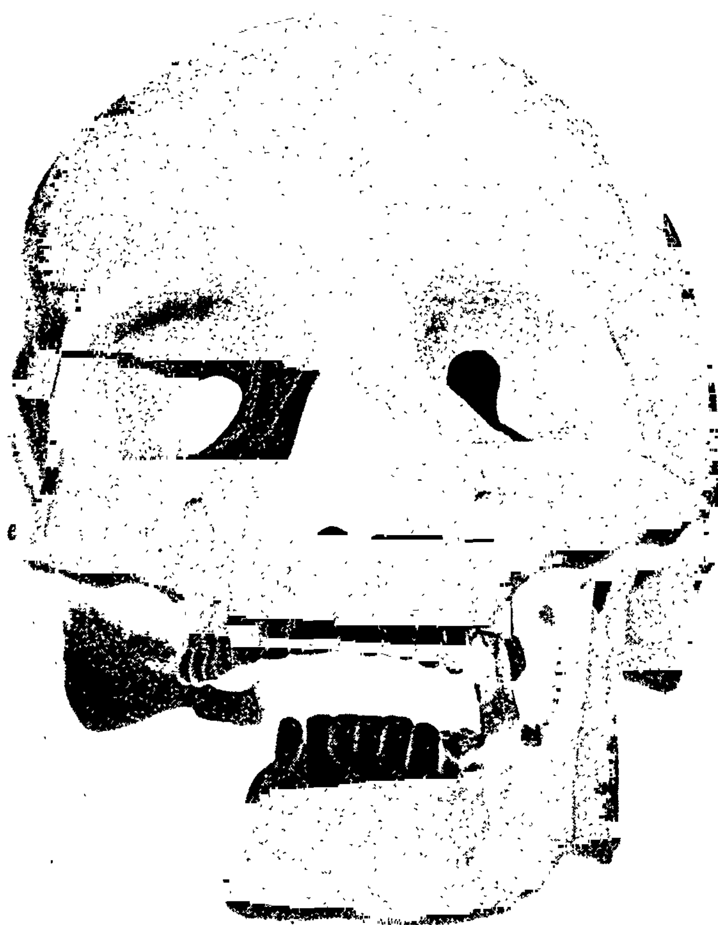


Fig. 212.—Text on page 387.

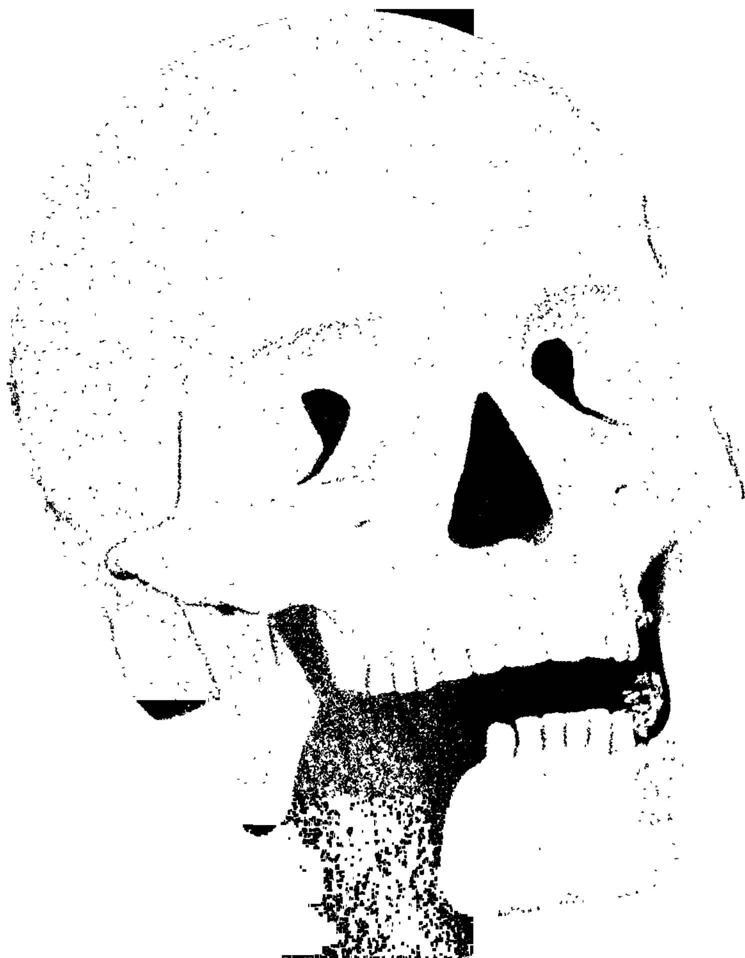


Fig. 213.—Text on page 391.

Fixation for Fragments of the Mandible When There Are Several Teeth in the Long Anterior Fragment and None in the Short Posterior Fragment (Fig. 213)

Should there be several teeth in the anterior, but none in the posterior fragment, it is advisable to construct a cast silver splint with a buccal flange (figs. 211 and 213). This splint is cemented to the posterior teeth of the long fragment and, as the patient opens and closes his mouth, the flange rides on the buccal surface of the opposing upper teeth. If such an appliance is used, the long anterior fragment cannot be displaced mesially and will maintain its proper relation to the upper dental arch. Although the posterior fragment is likely to be rotated anteriorly and upward by muscular traction, this is of no concern until time for insertion of the bone graft. The displacement of the posterior fragment can be corrected later, as will be described in Part II, Problem 50, of this chapter.

Fixation When Both Mandibular Fragments Are Edentulous

If both fragments of a mandible are edentulous, no splint is available for retaining the fragments in normal position during the interval of waiting, between the time of the injury and the time when it is safe to proceed with insertion of a bone graft. However, this problem is of little significance even though scar tissue does pull the fragments together, since the final contour of the lower alveolar ridge is of no great importance when a mandible is edentulous.

PART II

FIXATION OF THE BONY FRAGMENTS OF THE MANDIBLE FOR IMMOBILIZATION OF THE BONE GRAFT

Two factors are essential to successful bone grafting: perfect asepsis and perfect immobilization. Since the mechanical devices for fixation of the fragments must be applied the day before insertion of the transplant, this phase of the technic should be discussed first. Any appliance designed for fixation of the fragments must do more than merely hold the fragments; it must maintain correct dental occlusion. Furthermore, it must be so constructed that it will give adequate immobilization during the time necessary for the graft to unite with the fragments, a period usually of six to eight weeks. Here again, the type of fixation to be used in each case depends entirely on the teeth which are present in the segments of the lower jaw and in the maxilla.

In bone grafting to the mandible, we disapprove of the use of appliances for external skeletal fixation. The most undesirable feature of these devices is that they are likely to interfere with surgical exposure of the fragments and with application of the graft. In addition, the bone pins or screws used with such appliances have a tendency to become loose before strong bony union has developed between the graft and the fragments, thus permitting more or less displacement of the graft. Then, too, such appliances add risk to the operation, because of the possibility, remote though it is, of development of infection or necrosis in the tissues surrounding the pins or screws.

Based on the number of teeth present in each fragment, there are six problems to be considered in fixation of the bony fragments for immobilization of the bone graft. These problems include every type of fixation which is necessary for immobilization of any bone graft to the mandible. The problems are discussed on pages 394 to 406.

Fixation When Both Mandibular Fragments Are Edentulous

If both fragments of a mandible are edentulous, no splint is available for retaining the fragments in normal position during the interval of waiting, between the time of the injury and the time when it is safe to proceed with insertion of a bone graft. However, this problem is of little significance even though scar tissue does pull the fragments together, since the final contour of the lower alveolar ridge is of no great importance when a mandible is edentulous.

FIXATION OF FRAGMENTS FOR IMMOBILIZATION OF BONE GRAFT. TEETH PRESENT IN BOTH FRAGMENTS AND IN UPPER JAW (FIG. 214)

Under the conditions of this problem, we employ the same type of fixation as was described in Problem 44, Part I, of this chapter; this includes a sectional hinged splint over the long fragment, an anchor clamp band having a buccal sheath to a molar tooth in the short posterior fragment, and a rod connecting these two parts together (figs. 208 and 209). The buccal segments of the silver splint are constructed with external buttons or with hooks for the attachment of intermaxillary wires. Applied to the upper dental arch is a half round or full round wire arch bar, which is made secure by wiring to each upper tooth. It is inadvisable to use on the upper teeth single loop or continuous loop wires, as these may tend to stretch and then gradually will permit some displacement of the segments of the lower jaw. Strong intermaxillary wires connected to the arch bar above, and to the hooks on the silver casting below, complete the steps necessary for thorough immobilization of the fragments.

For details concerning construction of the silver splint, see page 571.



Fig. 214.—Text on page 395.

Fixation of Fragments for Immobilization of Bone Graft. Teeth Present in Both Fragments but Upper Jaw Is Edentulous (Fig. 215)

Under the conditions of this problem, we employ the same type of fixation as that described in Problem 44, Part I, of this chapter; this includes a sectional hinged splint over the long fragment, an anchor clamp band with a buccal sheath attached to a molar tooth in the short posterior fragment and a rod connecting these two parts together (figs. 208 and 209).

For further immobilization, particularly to prevent the patient from opening his mouth, a plaster head cast is constructed in which is incorporated a metal band having three posts for attachment of various appliances (fig. 215). Then, traction wires inserted through the cheeks are attached to the silver splint below and to the adjustable hooks on the head cast. The hooks on the head cast should be so adjusted that there is no lateral pressure of the traction wires on the soft tissues of the cheeks; this prevents unnecessary scarring of the cheeks. This arrangement of traction wire from the splint to the head cast gives perfect immobilization for the fragments of the lower jaw.

For details of construction of the plaster head cast see pages 479 to 495.

For details concerning insertion of traction wires through the cheeks, see pages 536 to 539.

For details concerning construction of the silver splint, see page 571.



Fig 215. Text on page 397.

Fixation of Fragments for Immobilization of Bone Graft. Teeth Present in Long Anterior Fragment and in Upper Jaw; No Teeth in Short Posterior Fragment (Fig. 216)

In this situation, the long fragment containing teeth is made immovable by means of intermaxillary wires stretched between half round or full round wire arch bars. The posterior fragment, on the other hand, is pulled backward and immobilized by a wire which is attached to a hook incorporated in a plaster head cast.

Surgically, the angle of the mandible must be exposed. See pages 540 to 549. A hole is drilled close to the angle and a double strand of 26-gauge bronze or stainless steel wire is inserted. This wire is twisted to form a loop externally to which a rubber band or wire can be attached for fixation to the hook on the head cast.

Care should be taken in this operative procedure to expose no more of the angle of the mandible than is absolutely necessary. It is also advisable to wait until the inflammatory reaction subsequent to insertion of the traction wire has entirely disappeared before proceeding with transplantation of the bone graft. Usually, this is a matter of about three weeks. It is to be remembered that this wire, when under tension, can pull completely through the bone in six to eight weeks. Therefore, in order that it may provide immobilization of the fragment during the six to eight weeks during which the bone graft is healing, it is important that the wire be left unattached to the hook which extends from the plaster head cap until the day before the bone grafting operation. This form of immobilization does not prevent slight mesial or lateral displacement of the edentulous fragment. However, this amount of motion does not interfere with healing of the bone graft.

For details of construction of the plaster head cast, see pages 479 to 495.

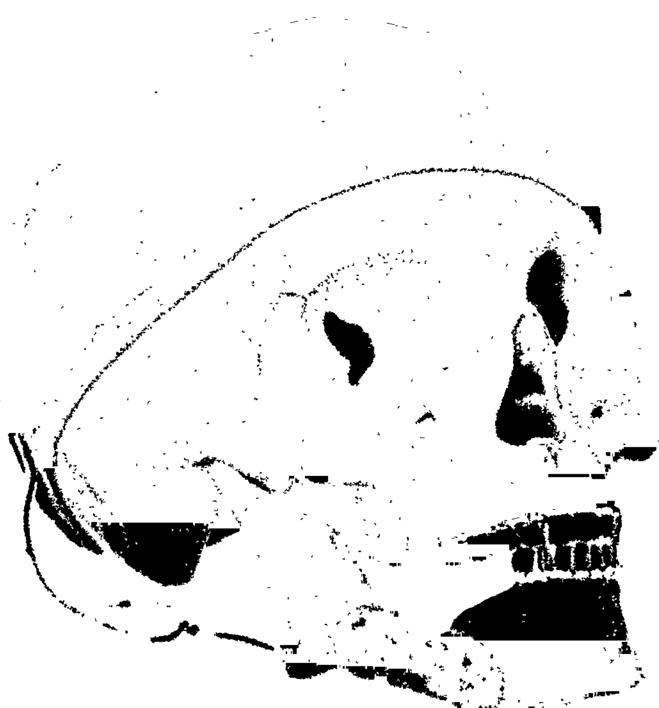


Fig. 216 Text on page [illegible].

Fixation of Fragments for Immobilization of Bone Graft. Both Fragments and Upper Jaw Edentulous (Fig. 217)

Under these circumstances, there is no entirely satisfactory method of immobilization of the fragments. However, as in shown in figure 217, wires attached to the two fragments and fixed to a plaster head cast, under ordinary circumstances, give sufficient fixation.

Both fragments of the mandible must be exposed surgically through small incisions in the regions shown in figure 217. A hole is drilled through each fragment and a double strand of 26-gauge bronze or stainless steel wire is inserted into each hole. The free end of each of these wires is twisted to form a loop externally, to which a rubber band or wire can be attached for fixation to the corresponding hook that extends from the head cast.

Care should be taken in these operative procedures to expose no more bone than is absolutely necessary. It is also advisable to wait until the inflammatory reaction subsequent to insertion of these wires has entirely disappeared before proceeding with transplantation of the bone graft. Usually this is a matter of about three weeks. It is to be remembered that these wires, when under tension, can pull completely through the bone in six to eight weeks. Therefore, in order that they may provide immobilization of the fragments during the six to eight weeks during which the bone graft is healing, it is important that the wires be left unattached to the hooks that extend from the plaster head cap until the day before the bone grafting operation.

For details of construction of the plaster head cast, see pages 479 to 495.

For details of insertion of wires into the bony fragments, see pages 540 to 549.



Fig. 217. Text on page 401.

FIXATION OF FRAGMENTS FOR IMMOBILIZATION OF BONE GRAFT. DEFECT IN ANTERIOR PART OF MANDIBLE. SEVERAL TEETH PRESENT IN BOTH LOWER FRAGMENTS AND IN UPPER JAW (FIG. 218).

Under the conditions of this problem, we employ a sectional hinged splint such as was described in Problem 43, Part I, of this chapter (figs. 205 and 206).

The buccal segments of this appliance are furnished with buttons or hooks for the attachment of intermaxillary wires. Applied to the upper dental arch is a half round wire arch bar (not shown in fig. 218), which is made secure, by wiring, to each upper tooth. Strong intermaxillary wires (not shown in fig. 218) are connected to the arch bar above, and to the hooks on the silver casting below, before the bone grafting operation.

For details concerning construction of the silver splint, see pages 565 to 569.



Fig. 218.—The half round wire arch bar wired to the upper dental arch and the double intermaxillary wires for immobilization are not shown. Text on page 403.

Fixation of Fragments for Immobilization of Bone Graft. Defect in Anterior Part of Mandible. Only One or Two Molar Teeth Present in Each Lower Fragment (Figs. 219 and 220)

Frequently when bone has been lost from the anterior portion of the mandible, only one or two lower molar teeth are left on either side for fixation (fig. 219). Regardless of whether these teeth are loose, they should be retained for fixation of the fragments. However, when so few teeth remain, it is useless to employ a sectional splint. Instead, we attach an anchor clamp band having a buccal sheath to a molar tooth in each fragment; then, a round wire arch bar, properly bent, is inserted into the sheaths of these molar bands so as to maintain the desired distance between the fragments (fig. 220a). This round wire arch bar is prevented from slipping out of the sheaths of the molar bands by wires stretched from the bent portion of the arch bar around the sheaths of the molar bands (fig. 220 b and c). Immobilization of the fragment then is completed by use of intermaxillary wires stretched between wires on the upper teeth and the sheaths of the molar bands below.

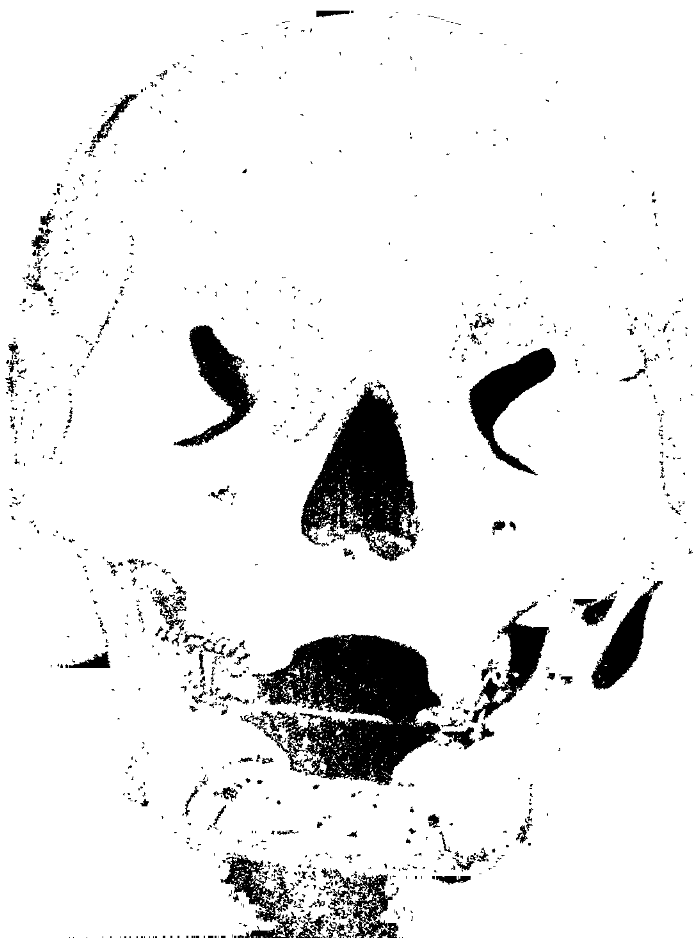


Fig. 219.—Text on page 405.

PART III

DETAILS OF TECHNIC NECESSARY IN TRANSPLANTATION OF BONE TO THE MANDIBLE

CHOICE OF BONE FOR GRAFT

The anatomic regions from which sections of bone can be obtained for implantation over the mandible are numerous. The tibia, crest of the ilium, ribs and clavicle have been used for this purpose. In addition, sliding inlay grafts from the jaw bone itself have been employed. Just which one of these sites offers the best type of bone for transplantation is debatable. In view of the experimental work which has been done by many workers in recent years, there should be some scientific basis for selecting the region from which bone most suitable for grafting can be obtained. Since a bone graft undergoes gradual distintegration and regeneration, it would seem that the type of graft to use would be one composed of somewhat spongy or porous bone. Not only has it been demonstrated that a graft made of extremely compact bone is vascularized slowly, but its union with the fragments of the jaw also is much delayed when compared with the time required for completion of these physiologic processes if the graft is porous and cancellous. There has been much discussion as to whether or not much of a graft should be cancellous. Although some experimental work would indicate that an excess of bone marrow has a detrimental effect on the tissue reactions about a bone graft, it is our opinion that a rather porous type of graft, containing some cancellous bone, will give better results generally than will one composed of very compact bone.

Taking the foregoing factors into consideration, we believe that bone obtained from the crest of the ilium, or from a rib, is preferable to that obtained from other sites. The structure of the crest of the ilium and the ribs is similar; both contain much cancellous bone beneath moderately thin cortical bone. On

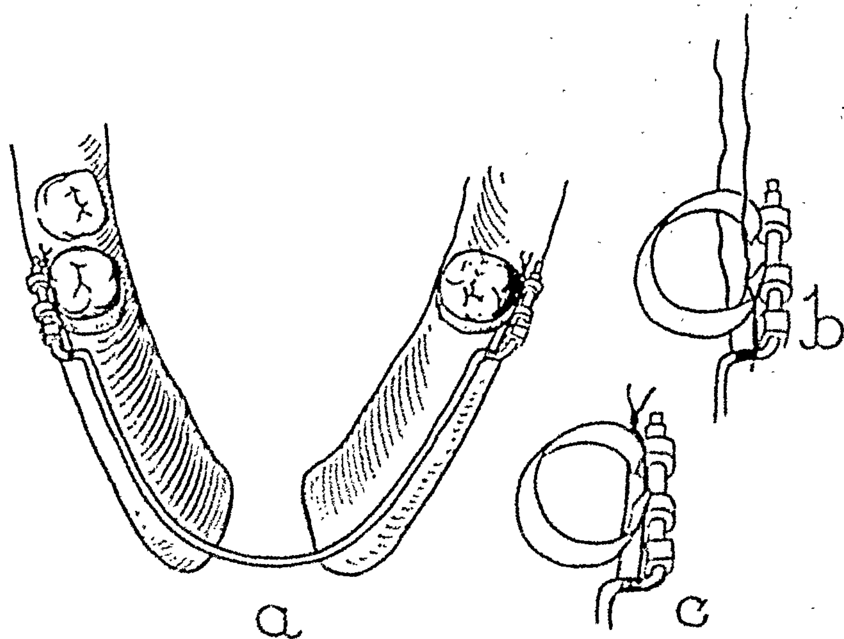


Fig. 220. Text on page 405.

the other hand, sliding inlay grafts from the mandible, and implants from the tibia, are composed of bone which is too compact to warrant their use. Bone from the clavicle we also do not employ because if enough bone for a transplant is taken from the clavicle the shoulder girdle is weakened.

If costal bone is to be employed, we recommend cutting out a section of rib of the necessary length and splitting it longitudinally; one or the other half is then selected for grafting. Since it is technically more difficult to secure bone from a rib than from the ilium, and since it causes the patient more postoperative discomfort, we have chosen the crest of the ilium as the best site from which to obtain bone for grafting the mandible.

In removing bone from the ilium, a slightly curved incision is made in the skin over the anterior superior spine. The incision follows the line of the crest and extends inferiorly far enough to allow of good exposure (fig. 221). After the subcutaneous tissues have been incised, the muscular attachments to the bone are effectively removed by means of periosteal elevators. When the crest has been completely exposed, very thin, double-beveled chisels are employed to obtain a piece of bone of the required size. On removal of the graft from its bed, it is well to insert a drain which provides an outlet for escape of any serum which may collect in the depths of the sutured wound.

There has been considerable difference of opinion as to whether or not the periosteal covering should be allowed to remain on a graft. Experimental work along this line would indicate that the cellular elements of the periosteum die shortly after the graft has been placed in position, but the presence of the periosteum aids in early attachment of the surrounding connective tissue to the implant. Apparently, whether or not a graft is covered with its periosteum makes little difference in the ultimate healing of a bone graft but we think it preferable not to remove the periosteum.

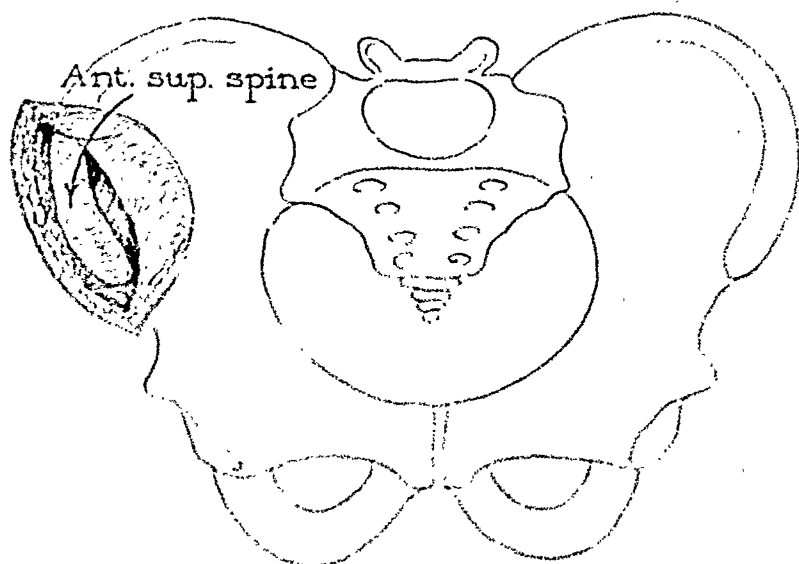


Fig. 221.—Exposure of the right crest of the ilium through a curved incision in the skin. Text on page 409.

PREPARATION OF FRAGMENTS FOR RECEPTION OF BONE GRAFT

Before implantation of a bone graft into the mandible, all of the appliances necesary for fixation of the fragments must be in proper position (figs. 214 to 220 inclusive). This type of operation progresses with the least difficulty if performed with the patient under intratracheal gas and ether anesthesia. Just below the mandibular defect, a cutaneous incision of sufficient length to give adequate exposure of the ends of the fragments is made. It is advantageous to make this incision at least 2 cm. below the lower border of the mandible, so that injury to the small branches of the facial nerve which supply a portion of the lower lip may be avoided. By blunt dissection, the end of the fragments are exposed and, with periosteal elevators, the soft tissues surrounding the ends of the fragments are pushed aside. The most vulnerable point for a nick or tear through the oral mucous membrane is along the upper edge (alveolar ridge) of each fragment. However, adequate exposure of the ends of the fragments can be obtained without freeing the soft tissues over the alveolar border. Consequently, we believe that the tissues here should be left entirely alone, thus avoiding possible perforation through the oral mucous membrane.

Following exposure of the outer (buccal) and inner (lingual) surfaces, as well as of the lower border of each fragment, the free end is ground down and beveled outward for a distance of about 2 cm. (fig. 222). The grinding is continued until fairly free bleeding occurs from the cancellous portion of the bone. In this preparation of the end of the bony fragment, it is desirable to grind away the bone with a motor driven burr rather than to remove it with chisels, because the force exerted by a mallet against a chisel is sufficient to displace the dental appliance needed for subsequent fixation of the fragments. The foregoing technic completes the preparation of the fragments for reception of the bone graft.

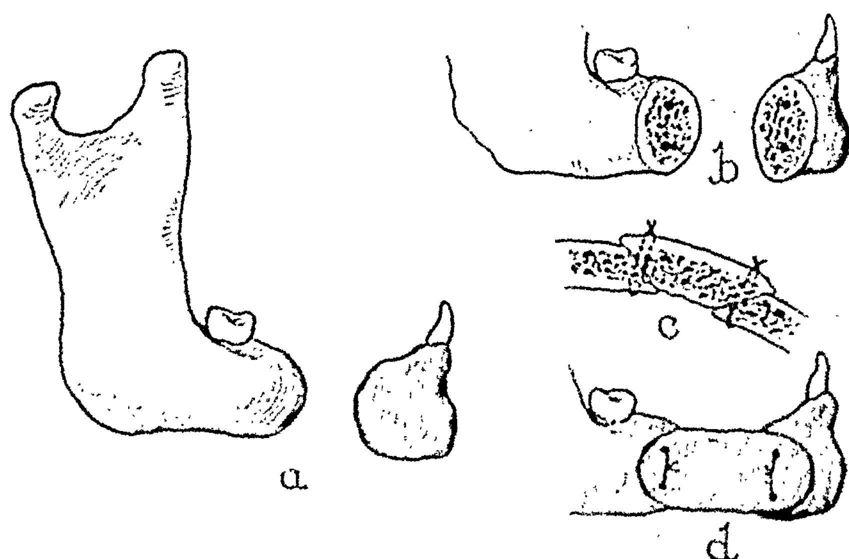


FIG. 222.—Surgical preparation of the bony fragments for reception of a bone graft. a. The relation of the fragments to the defect. b. The end of each fragment has been ground down and beveled outward, exposing the cancellous bone. Two holes have been drilled in each fragment. c. Bone graft (as seen from below and in longitudinal section) has been cut to fit between the two fragments. Two heavy catgut ligatures inserted through the holes maintain the bone graft in proper position. d. Bone graft tied in position (as seen from the lateral surface). Text on pages 411 and 412.

below the lower border of the mandible. This projection of the graft we do not attempt to remove; as was shown in figure 202, all of this excess bone is absorbed gradually and the ultimate contour of the mandible is essentially normal.

NECESSITY OF REMOVING INTERMAXILLARY WIRES AFTER OPERATION

It is always preferable to perform bone graft operations under general anesthesia, preferably by the intratracheal method. However, if the jaws are wired together, there is considerable danger of the patient aspirating vomitus following the operation. Furthermore, the airway may become obstructed otherwise, such as by falling back of the tongue. It is, of course, essential that the jaws be wired tightly together in normal position during the operation so that the fragments of the mandible will assume correct alinement when the bone graft is attached.

We solve these difficulties in the following manner: All of the fixation appliances are placed in position prior to the operation, except intermaxillary wires. After the patient has been anesthetized and the intratracheal tube has been inserted, the intermaxillary wires are applied. Immediately following the operation, the intermaxillary wires are removed, which permits the patient's mouth to be opened during the stage of nausea and vomiting. The next morning following the operation, if vomiting has ceased, intermaxillary wires are reapplied for fixation of the fragments. During the interval between the operation and the time at which the intermaxillary wires are reapplied, the catgut sutures which hold the bone graft in place offer temporary immobilization for the bone graft.

INSERTION OF BONE GRAFT

By means of rongeurs and bone chisels, the transplant itself is cut to the desired shape and its ends are beveled to approximate the ends of the bony fragments. Two holes are drilled through the ends of the fragments as well as through each end of the bone graft and, by use of heavy dermal catgut, the graft is tied to the fragments (fig. 222). It is our opinion that wire, kangaroo tendon or other nonabsorbable material should not be used for attachment of the bone graft. Instead, reliance should be placed on the mechanical devices already described for fixation. The ligature need hold the graft for only ten days to two weeks, at the end of which time sufficient fibrinous exudate and loose fibrous tissues will have formed to maintain the implant in the desired position. Consequently, we believe that it is better to use some material such as catgut, which is absorbable. Following implantation of the graft, the soft tissues are sutured tightly without drainage. In the average case, immobilization is maintained for six to eight weeks.

Some surgeons are employing cancellous bone chips from the crest of the ilium to correct bony effects of the mandible. These chips are merely packed into the wound between the fragments, no attempt being made to fix them in position. In our experience, such bone chips give satisfactory results if the width of the bony defect does not exceed a few millimeters. However, when there is considerable loss of bone, we believe that a good functional result can be obtained only by using a single piece of bone to bridge across the defect. In general, we prefer a rather large graft, even though its margins may protrude beyond the normal contour of the mandible. Any excess or protuberance of a new bone transplant will undergo gradual resorption, so that ultimately the normal configuration of the mandible in the region of the defect will be established.

When, for reasons of immobilization, it is necessary to retain a tooth of which the roots are located close to the end of a fragment, we prefer to attach the bone graft in a position lower on the mandible than that portion of it which surrounds the roots (figs. 200 and 201). If this is done, the graft has a broader surface of attachment but also may protrude conspicuously

below the lower border of the mandible. This projection of the graft we do not attempt to remove; as was shown in figure 202, all of this excess bone is absorbed gradually and the ultimate contour of the mandible is essentially normal.

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Fig. 223.—Text on page 415.

RECONSTRUCTION OF RAMUS (FIGS. 223 to 226 Inclusive)

Loss of one ramus of the mandible is of fairly common occurrence in war (fig. 223). Such a defect seriously interferes with mastication, since the remaining portion of the mandible is drawn to the side of the loss. In reconstructing the lost part by means of a bone graft, it is to be remembered that the graft itself is never concerned with the subsequent functions of the mandible; it merely retains the lower jaw in its proper relation to the upper dental arch. It is our opinion that if the loss of bone extends forward beyond the region of the premolar teeth on the affected side, then the defect is too extensive to warrant use of a bone graft. This is true because the graft would be too bulky and heavy for the remaining portion of the mandible to operate during mastication. Under such circumstances, use of a prosthesis rather than a bone graft must be considered, even though the former is none too satisfactory.

For reconstruction of the ramus and a portion of the body of the mandible, either a rib or the crest of the ilium can be employed. In our experience, both are satisfactory, although we prefer the crest of the ilium since its anterior superior spine forms an excellent angle for the reconstructed ramus (fig. 224). As a matter of fact, bone taken from the crest of the ilium can be trimmed to a shape which very nearly conforms to the contour of a normal ramus. One must. of course, use the iliac bone corresponding to the side of the defect and measurements of the graft must be determined in advance. The soft tissue about the ilium is stripped away until sufficient bone is exposed and, on removal, the section of bone is cut to the desired configuration with rongeurs and chisels (figs. 224 and 225). After the mandible has been immobilized by dental wiring, a small cutaneous incision is made below the free end of the mandible. With blunt forceps a tract or cavity is created deep to the masseter muscle, extending from the incision to the glenoid fossa. Technically, this is not difficult to accomplish if caution is employed. Next, the free end of the jaw bone is exposed, is ground down and is beveled outward as has been described previously. The graft itself is inserted into this artificially created tract (fig. 225) and is attached by a catgut ligature to the prepared end of the

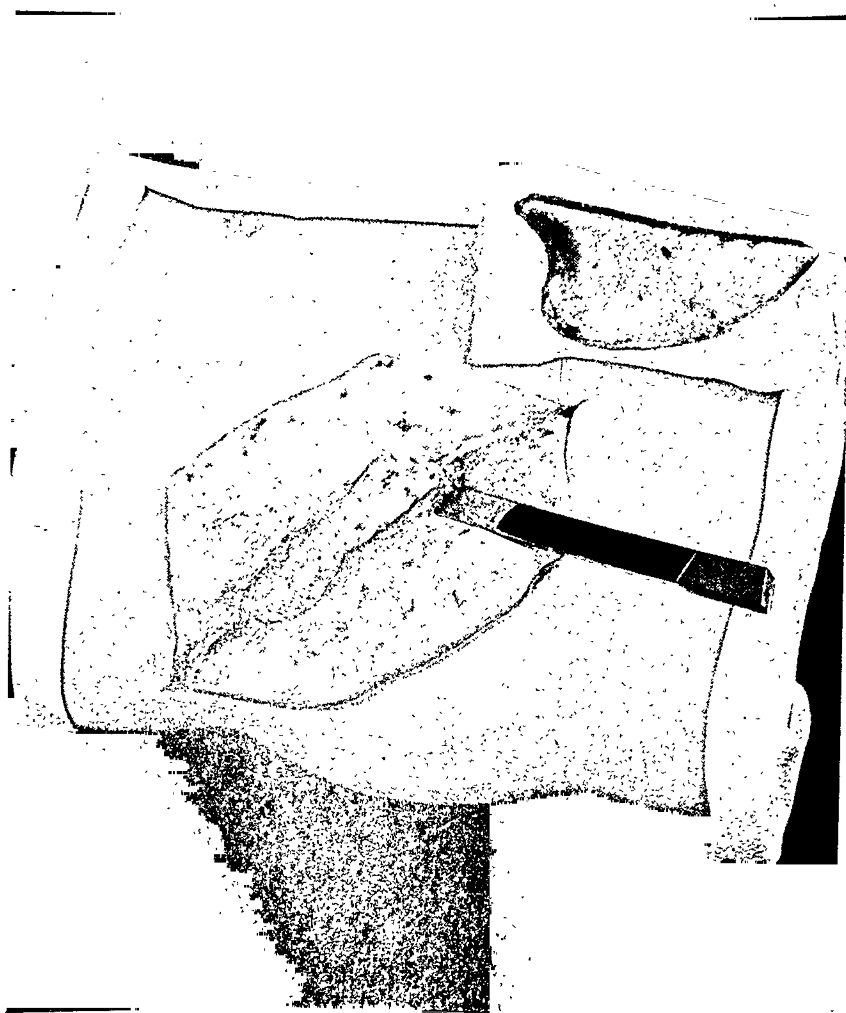


Fig. 224.—Text on page 415.



Fig. 225.—Text on page 415.

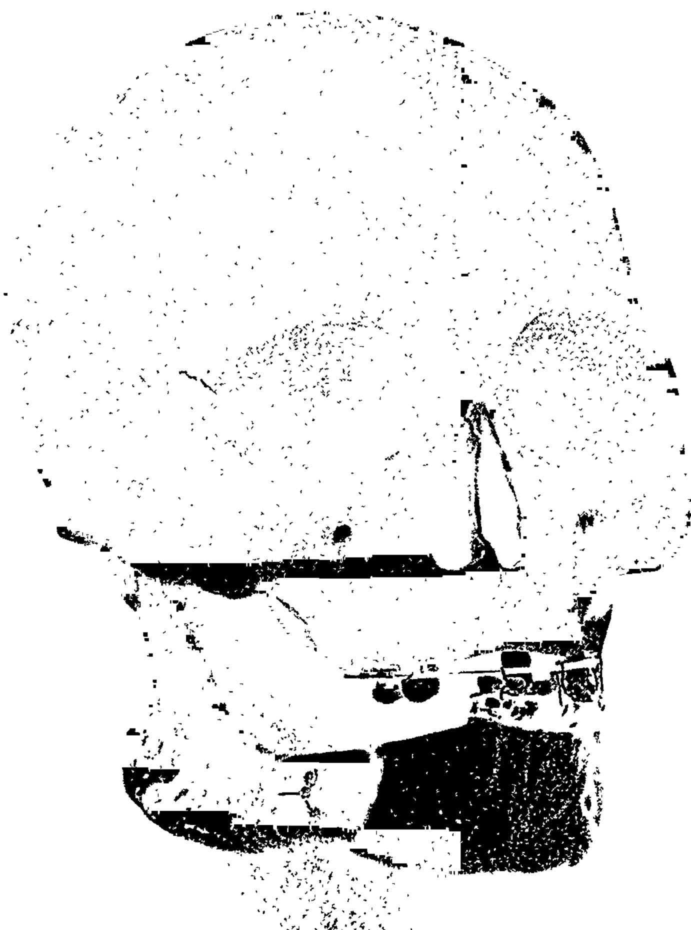


Fig. 226.—Text on page 419.

mandible. A satisfactory functional and cosmetic result may be anticipated if the operative procedure is carried out aseptically and if immobilization of the mandible is secured by mechanical devices (fig. 226).

CAUSES FOR FAILURE OF BONE GRAFT TO UNITE WITH A FRAGMENT

The most common causes for failure of a bone graft to unite with a fragment are:

1. Poor apposition of the graft and the fragment.
2. Insufficient surface contact between the ground-down end of the fragment and the end of the graft.
3. Sclerosis of the end of the fragment.

Although it is not essential that the graft and the end of the fragment fit flush, still there should be as wide a contact surface as possible. This is secured by grinding the surfaces until they rest firmly together. Should the end of a fragment be sclerosed or eburnated, it should be ground away until healthy cancellous bone is reached, as is exhibited by proper hemorrhage.

PREVENTION AND TREATMENT OF INFECTIONS ATTENDING BONE GRAFTING

Since infection is the most serious complication attending bone grafting, this subject deserves considerable attention. Sprinkling a small amount of powdered sulfathiazole or other sulfonamide compound in the wound after transplantation of the graft is to be recommended. There can be little doubt that these drugs aid in overcoming many infections. However, should the wound become grossly contaminated by secretions from the mouth entering through a nick in the oral mucous membrane, then one local application of these drugs probably would be ineffectual. Should a definite purulent infection develop about a bone graft, the implant need not necessarily be lost. In such cases, we have found it helpful to insert a small through-and-through rubber tube drain alongside the graft. Usually this drain can be inserted through one draining sinus and brought out through another sinus or counteropening. That part of the drain which is situated within the wound should have multiple perforations, and this



Fig. 226.—Text on page 419.

CHAPTER IX

DEFECTS OF THE FACIAL BONES WHICH REQUIRE RESTORATION OF CONTOUR

IT is not our intention to include in this book a detailed discussion of plastic reconstruction of the face. Yet, what plastic surgery can contribute to treatment of residual deformities produced by traumatic injuries to the bones of the face is worth consideration.

Such deformities present the following problems:

1. Loss of the anterior part of the mandible, requiring for reconstruction a bone graft, an intra-oral skin graft and intra-oral prosthesis.
2. Loss of half or more of the mandible, requiring an intra-oral skin graft and intra-oral prosthesis.
3. Loss of a portion of the upper jaw, requiring an intra-oral skin graft and intra-oral prosthesis.
4. Loss of the lower border of the anterior part of the mandible, necessitating a cartilage graft for reconstruction of the chin.
5. Old, depressed fracture of a malar bone requiring a cartilage graft to reconstruct the contour of the cheek.
6. Old, comminuted fracture of a malar bone together with comminution of the floor of the orbit, requiring a cartilage graft to elevate the level of the eyeball.
7. Residual, traumatic, saddleback nasal deformities, requiring a cartilage graft to reconstruct the bridge of the nose.

There are many other defects of the nasal bones and cartilages which require plastic repair other than, or in conjunction with, cartilage grafts. Discussion of such nasal deformities, however, would require an entire volume and will not be attempted here

drip connector. By means of this apparatus, diluted solution of sodium hypochlorite (modified Dakin's solution) is permitted to flow very slowly and continuously through the wound for several days. In our experience, this procedure has been definitely effective in saving a few infected bone grafts. It is possible that other solutions, such as one of a sulfa drug, if used in a similar manner to irrigate the wound, might produce as good, or better, results.

Traumatic Loss of the Anterior Part of the Mandible, Requiring for Reconstruction a Bone Graft, an Intra-oral Skin Graft and Intra-oral Prosthesis (Figs. 227 to 230 Inclusive)

COMMENTS

A not uncommon traumatic injury, particularly an injury of war, is loss of the anterior part of the mandible (fig. 227). Such a defect may be due either to the injury itself or to secondary osteomyelitis with sequestration. Particularly when a result of the former cause, there is likely to be associated loss of the overlying soft tissues of the chin. Patients who have lost the anterior part of the mandible are unable to eat solid foods; often they drool and are conspicuously conscious of their deformity. Consequently plastic repair is necessary to restore not only function but also facial contour.

This type of traumatic defect requires, first, reconstruction of the soft tissues and, later, a bone graft to establish continuity of the mandible (fig. 228). However, a bone graft does not necessarily correct the external deformity. The loss of bone may involve so much of the anterior part of the mandible that even after the bone graft, which bridges the gap between the two lateral fragments, has been inserted the chin still is flat. Furthermore, even if the bone graft does re-establish the normal contour of the chin, the tissues of the lip usually are fixed by scarring to the soft tissues of the floor of the mouth, a defect which also requires correction. In either case, the lip must be freed by an intra-oral incision, which leaves a raw surface that must be lined with skin. Subsequently, an intra-oral prosthetic appliance is constructed to fit into the skin-lined pocket; the appliance, which is supplied with artificial teeth to reconstruct the lower dental arch, holds the lower lip forward in normal position. If the bone graft does not re-establish the normal contour of the chin, the intra-oral pocket can be extended down in front of the bone graft. An intra-oral prosthetic appliance fitting down into the depths of such a pocket can be so constructed as to restore the natural contour of the chin (figs. 229 and 230).



Fig. 227.—Text on pages 423 and 427.



Fig. 229.—Text on page 423.



Fig. 228.—Text on pages 423 and 427.

TREATMENT

If soft tissues in the region of the chin are lost, reconstruction of these soft parts should be deferred for three to six months, until all of the inflammatory induration and thickening resulting from the original injury have disappeared. If repair of the soft parts requires transplantation of skin, a tubed pedicle flap can be elevated and prepared during this interval of waiting but application of the graft to the chin will not be described here.

Three months or more after the soft tissues of the chin have been reconstructed, a bone graft can be inserted to re-establish continuity of the mandible. The details of fixation of the fragments and of application of the bone graft itself have been described in chapter VIII. See figures 227 and 228.

Three months or longer after the bone graft has united with the bony fragments, a pocket is made in the soft tissues in front of the bone graft. In the following pages, our method of making and lining such a raw pocket with a shaved, epidermic skin graft is described in detail.



Fig. 230.—Text on page 423.

INTRA-ORAL SKIN GRAFTING (FIG. 231)

If the lower lip and soft tissues of the chin are to be freed from the underlying structures in order that a pocket may be created into which a prosthetic appliance can be inserted, sharp dissection must be employed. An incision is made through the mucous membrane in the region of the labio-alveolar sulcus, from one bicuspid region to the other. This incision is then carried down in front of the bone graft (fig. 228), care being taken not to expose the graft. The result of this procedure is creation of a pocket which must be lined with skin for reception of the artificial appliance. Lining of the pocket with skin prevents formation of scar tissue and consequent contraction.

The difficulty in skin grafting such an artificially created cavity is in obtaining absolute fixation of the part during the period of healing of the skin graft. Immobilization, of course, is the most important factor in successful skin grafting. In order to obtain complete fixation of the skin graft, Dr. E. F. Trost and one of us (JBE) have developed a cast silver splint (fig. 231).

Details of the technic of using this splint are described and illustrated on pages 430 to 435.

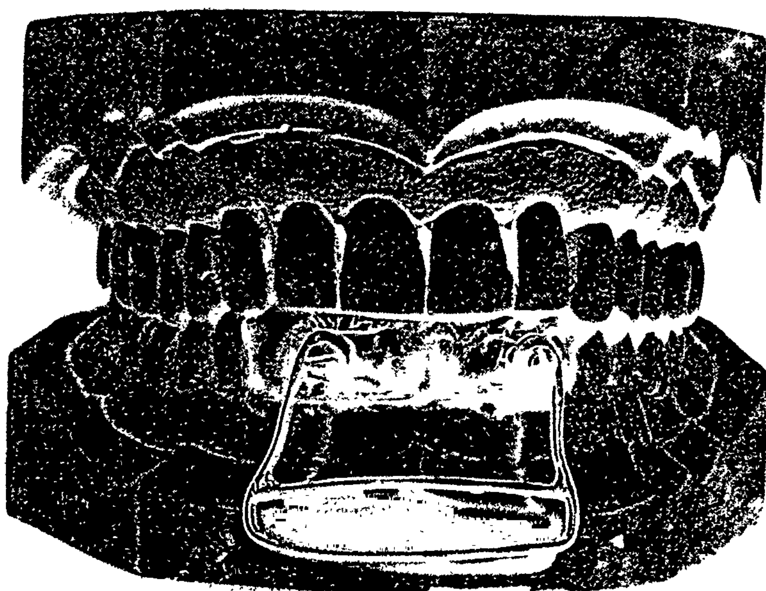


Fig. 231.—Text on page 429.

INTRA-ORAL SKIN GRAFTING (*Continued*). See figure 232

The dental splint which, as has been said, is cast in silver, fits over, and is cemented to, the lower anterior teeth. For details concerning construction of this splint, see page 587. On the anterior aspect of this splint are two threaded holes into which steel screws may be turned. A wire frame is also constructed which can be securely fastened, by the screws, to the splint (fig. 232). It is essential that a tap be available for threading the holes in the silver splint, the threads to be of a size that will receive the small steel screws. Following surgical preparation of the intra-oral pocket, the wire frame is fixed to the splint and is adjusted so as to lie in the center of the wound. It is then removed and is coated with a thin layer of dental modeling compound which has been melted in a flame. This compound, softened in this manner, will adhere perfectly to the frame, whereas compound softened in hot water will not.

This subject is continued on page 433.

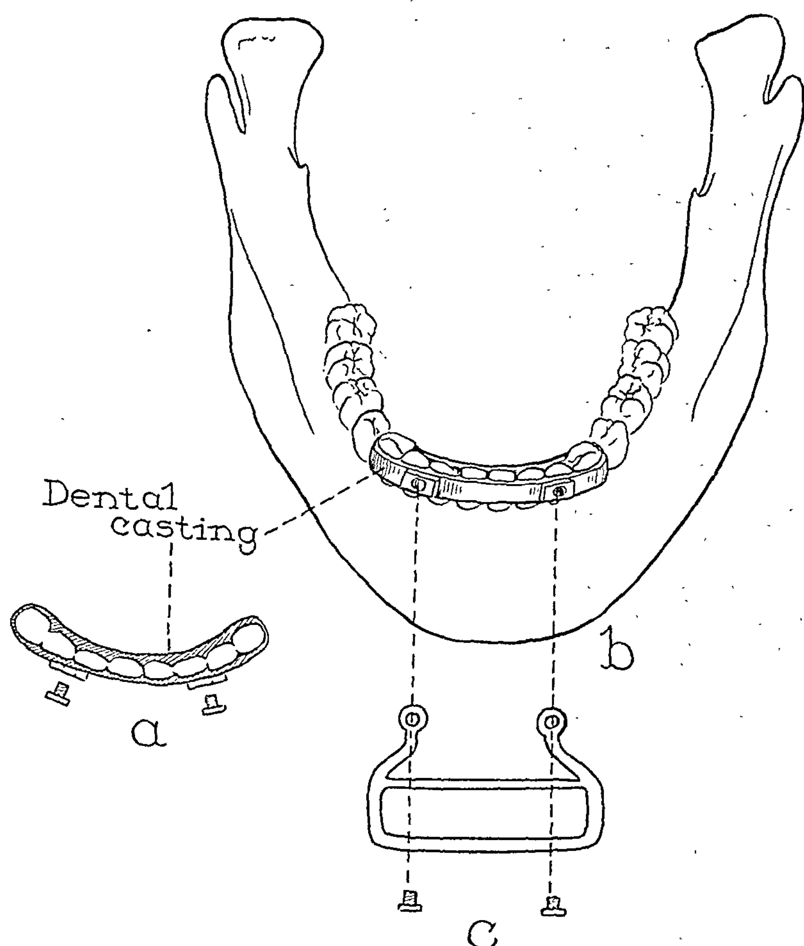


Fig. 232.—Appliance for fixation of a skin graft used in lining a pocket for reception of a prosthetic appliance: a, Case silver dental splint as seen from above; b, splint cemented to lower anterior teeth; c, wire frame for holding dental modeling compound, around which, in turn, the skin graft is wrapped; two small screws which anchor the wire frame to the splint also are shown. Text on page 431.

INTRA-ORAL SKIN GRAFTING (*Continued*). See figure 233

After the frame, covered thinly with dental modeling compound, has been reattached to the splint, a cake of modeling compound is softened in hot water and is packed down around the frame that now is suspended in the pocket. When hard, the compound and frame are securely united and together form a stent (mold) that is perfectly adapted to all the irregularities of the pocket. The stent is then removed from the mouth and is coated with rubber cement or mastisol (a solution of mastic in benzene). A thin, Thiersch skin graft (from the inner surface of the thigh), which was cut preliminary to the intra-oral operation, is wrapped about the stent (fig. 233, a) and is sutured along its upper surface (fig. 233, b). The stent, covered with the skin graft, is then inserted into the pocket and screwed to the dental splint. Complete coverage of the stent with the skin graft insures good fixation of the graft to the stent. That part of the skin graft which covers the upper part of the stent and which, therefore, protrudes from the raw pocket, eventually sloughs off. It is only that part of the graft which is in contact with the raw surface of the pocket which remains alive and lines the pocket.

This subject is continued on page 435.

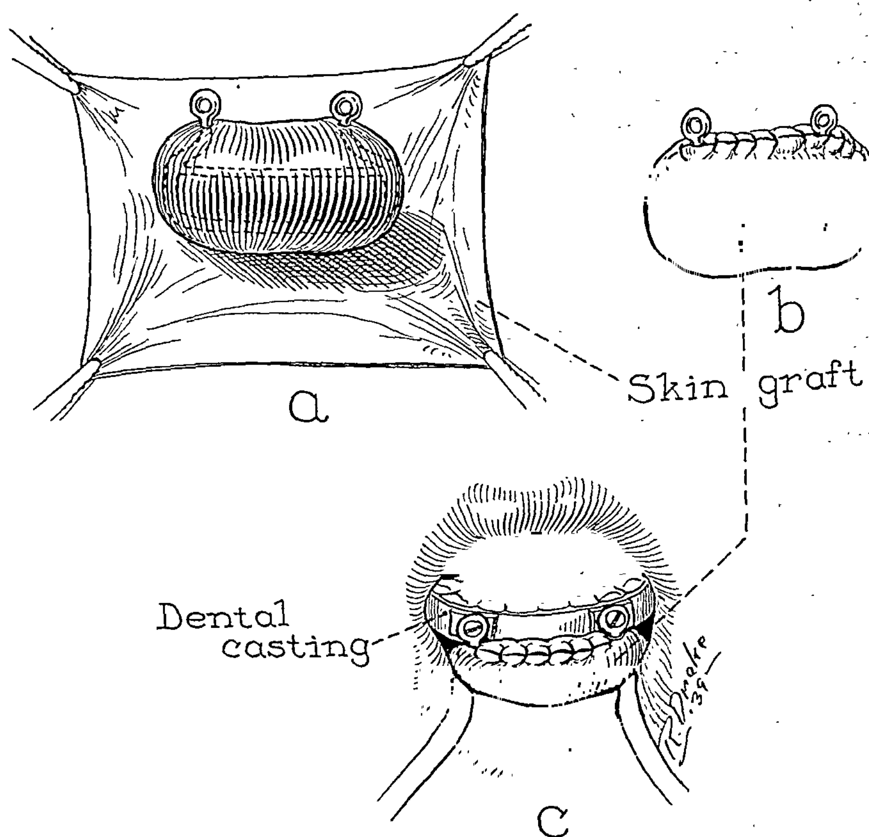


Fig. 233.—Application of skin graft to dental appliance. After dental modeling compound has been packed around the wire frame (fig. 232, c) and into the intra-oral pocket so as to form a stent for the cavity, a Thiersch skin graft from the inner aspect of the thigh is wrapped about this stent (a) which previously has been coated with rubber cement or mastisol; b, the skin graft is sutured over the upper surface of the stent; c, the lower part of the stent, covered with the skin graft, is inserted into the intra-oral pocket; the upper part of the graft covered stent is not in the pocket and is visible in this illustration. The method described gives perfect fixation of the graft during the period of healing. Text on page 433.

INTRA-ORAL SKIN GRAFTING (*Continued*). See figure 234

Following insertion of the skin graft and stent into the intra-oral pocket, and attachment of the stent to the silver splint by means of the steel screws (fig. 234), adhesive plaster (tape) is applied externally to fix firmly the lower lip and soft tissues of the chin over the stent. Everything should be left undisturbed for ten days; the patient, meanwhile, is fed a liquid diet through a catheter or through a Rehfus feeding tube inserted through the nose to the stomach. On removal of the stent after ten days, the cavity will be found to be lined perfectly with skin. The stent should then be cleansed and re-inserted for another five to seven days. After this time, the stent and silver splint may be removed and the dentist constructs the intra-oral prosthetic appliance.

Such a prosthetic appliance supports the soft tissues of the lip and chin forward in proper position and possesses artificial teeth for restoration of the lower dental arch; it improves the appearance of the face and restores function of the lower jaw. We recommend that the appliance be made of one of the acrylic compounds, which do not irritate the pocket, but detailed description of such a prosthetic device is unnecessary; it is made in a manner similar to that in which any partial denture with clasps for retention is made. If possible, one or two molar teeth on each side, even if loose, should be conserved for retention of the prosthetic appliance during the six months about which warning is now to be given.

The warning is this: During the time between removal of the stent and silver splint and insertion of the prosthetic appliance, the soft tissue pocket should be kept open with some material such as gauze; otherwise the pocket will contract until it will be impossible to insert the appliance. It is surprising to what extent these pockets will contract within an hour. After six months, however, there is no further tendency of such a pocket to contract. Then, if the teeth to which the prosthetic appliance is attached by clasps are loose, they should be extracted and a new appliance, in the form of a full denture, should be made.



Fig. 234.—Two retractors hold the lower lip down so as to render visible the upper part of the intra-oral skin graft wrapped around a stent, and the cast silver splint which retains the stent. Text on page 435.

MODIFIED INTRA-ORAL APPLIANCE FOR FIXATION OF A SKIN GRAFT (FIG. 235)

If a pocket behind the lower lip is to be created and lined with skin, but there are no lower anterior teeth, the silver splint represented in figures 231 to 234 inclusive cannot be employed. In the situation represented in figures 227 to 230 inclusive, lower anterior teeth are absent.

Under these circumstances, a splint with an anterior extension arm can be made to fit over the posterior teeth on one or the other side. The wire frame over which the stent is built can be attached to the extension arm (fig. 235). The details of using this type of splint are identical with those described on pages 431, 433 and 435.

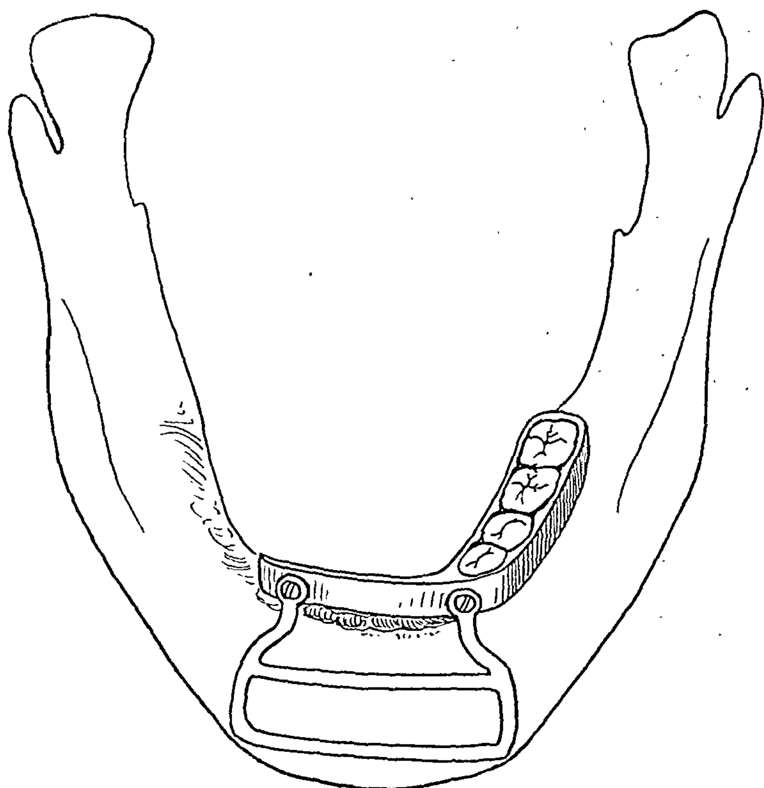


Fig. 235.—Text on page 437.

ANOTHER TYPE OF APPLIANCE FOR FIXATION OF AN INTRA-ORAL SKIN GRAFT (FIG. 236)

It is likely that many surgeons will not possess a tap for threading holes or a die for threading small steel screws to be used on the silver splint illustrated in figure 231. Under such circumstances, instead of threaded holes, a cast silver splint can be constructed with two or three hooks on the buccal surface (fig. 236). The wire framework to hold the stent of modeling compound can be prepared to fit up under these hooks on the splint. The pressure of the surrounding soft tissues continually forces the stent upward but the hooks prevent the skin covered mold from being forced out of the pocket.

This type of splint does not offer as perfect fixation for the skin graft as does the type illustrated in figure 231, but fairly good results can be obtained by its use.

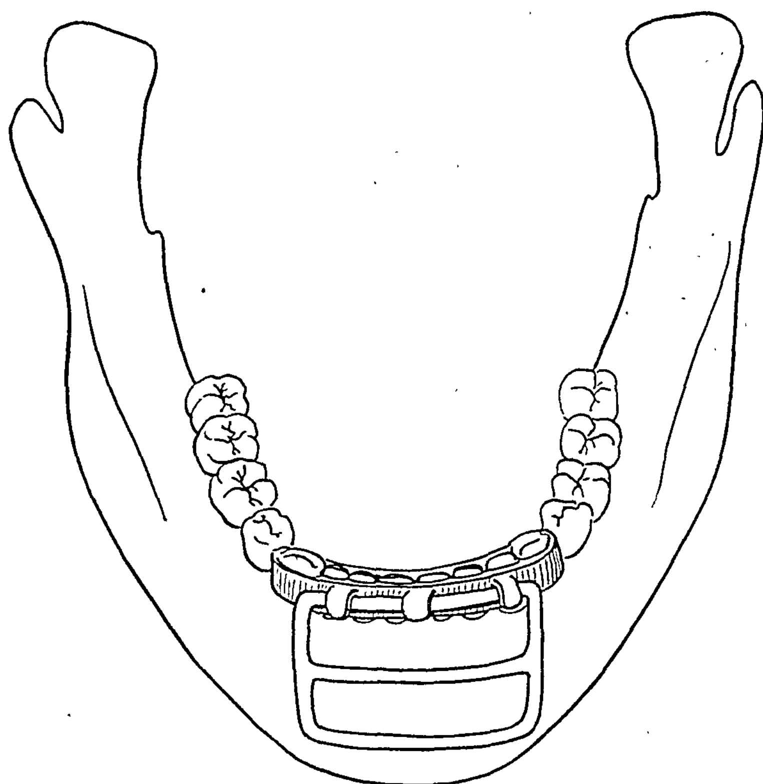


Fig. 236.—Text on page 439.

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Fig. 237.—Patient has spread her lips apart to show intra-oral stents. Text on pages 441 to 443.

Loss of Half or More of Mandible, Requiring an Intra-oral Skin Graft and Intra-oral Prosthesis (Figs. 237 to 241 Inclusive)

COMMENTS

If half or more of the mandible is lost through trauma or secondary osteomyelitis, the resultant defect is too extensive to warrant use of a bone graft. Such a graft would be so bulky and heavy that it would interfere with movement of the existing portion of the mandible. Under these circumstances, use of a prosthetic appliance rather than a bone graft must be considered.

It is difficult to discuss appliances to replace large portions of the mandible, because each one must be constructed to suit the needs in the individual case. No matter how ingenious such appliances may be, none of them functions entirely satisfactorily. This phase in the treatment of traumatic injuries of the mandible is in need of a great deal of experimental work. Prosthetic appliances used for the purpose under discussion are better than no appliance at all but this is about all the praise that we can offer in their behalf.

In most instances, the soft tissues in the region of the bony defect are badly scarred and distorted. They must be freed by an intra-oral incision, which leaves a raw pocket that must be lined with skin before the prosthetic appliance can be constructed and inserted. If teeth are present in the remaining portion of the mandible, the same type of silver splint and wire framework can be employed in immobilization of the skin graft as has been described in the previous pages (fig. 235). However, in many instances, the mandible is either completely edentulous or possesses only a few teeth which are so loose that they will not retain a silver splint. If such is the case, a rather satisfactory stent for immobilization of the skin graft can be constructed as is illustrated in figure 237. Details of this stent (mold) are discussed on page 443.



Fig. 237.—Patient has spread her lips apart to show intra-oral stents. Text on pages 441 to 443.

INTRA-ORAL STENT FOR IMMOBILIZING THE SKIN GRAFT IN AN EDENTULOUS MOUTH (FIGS. 237 and 238)

Dental compound in a metal tray is employed to obtain an impression of the upper jaw. When the compound has cooled and hardened, it is removed from the mouth and from the tray, and is re-inserted into the mouth.

A large bulk of softened dental compound is introduced into the mouth over the existing portion of the mandible and into the raw, surgically prepared, pocket on the opposite side. The patient bites into this soft compound and holds his jaw motionless until the compound cools and hardens. On removal, the mass of hard compound is trimmed and a hole is made in it anteriorly, through which a catheter or straw can be inserted for feeding the patient (fig. 238).

A thin, epidermic, shaved skin graft is wrapped about the lower mold. Both dental compound molds are then introduced into the mouth, and joined together by staples which are heated in a flame so that they can be introduced with ease into the compound. These staples should not be introduced, if the patient has been given general anesthesia, until the stage of nausea and vomiting resulting from the anesthesia has disappeared.

A gauze bandage is applied over the hair so that adhesive tape can be wrapped over the head and around, under the chin to stabilize the soft tissues of the lower lip and cheeks against the skin-covered stent.

The two piece stent is not removed for ten days, during which time the skin graft heals to the walls of the artificially created pocket. After this time, it is advisable to remove the stent and to prepare a two piece acrylic mold from it; the acrylic mold then is inserted into the mouth for another week or two (figs. 237 and 238).

When all of the raw surfaces within the mouth have completely healed, the prosthetic appliance can be prepared. Between the time of removal of the stent and insertion of the prosthetic appliance, the soft tissue pocket within the mouth should be kept open with some material such as gauze; otherwise the pocket will contract so that it will be impossible to insert the prosthetic device.



Fig. 238 Text on page 443.

INTRA-ORAL STENT FOR IMMOBILIZING THE SKIN GRAFT IN AN EDENTULOUS MOUTH (FIGS. 237 and 238)

Dental compound in a metal tray is employed to obtain an impression of the upper jaw. When the compound has cooled and hardened, it is removed from the mouth and from the tray, and is re-inserted into the mouth.

A large bulk of softened dental compound is introduced into the mouth over the existing portion of the mandible and into the raw, surgically prepared, pocket on the opposite side. The patient bites into this soft compound and holds his jaw motionless until the compound cools and hardens. On removal, the mass of hard compound is trimmed and a hole is made in it anteriorly, through which a catheter or straw can be inserted for feeding the patient (fig. 238).

A thin, epidermic, shaved skin graft is wrapped about the lower mold. Both dental compound molds are then introduced into the mouth, and joined together by staples which are heated in a flame so that they can be introduced with ease into the compound. These staples should not be introduced, if the patient has been given general anesthesia, until the stage of nausea and vomiting resulting from the anesthesia has disappeared.

A gauze bandage is applied over the hair so that adhesive tape can be wrapped over the head and around, under the chin to stabilize the soft tissues of the lower lip and cheeks against the skin-covered stent.

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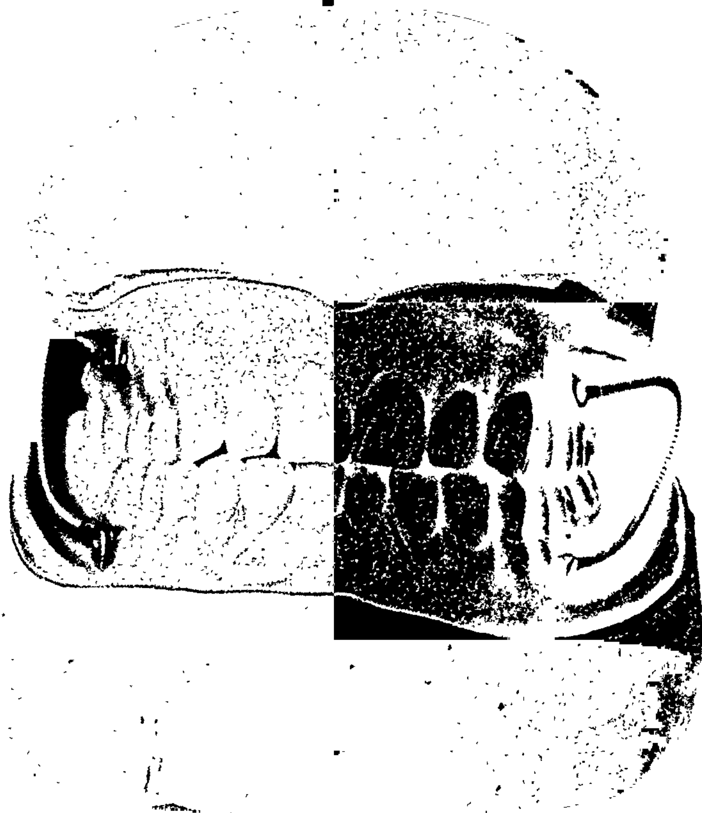


Fig. 239. Text on page 445.

PROSTHESIS FOR RECONSTRUCTING HALF OR MORE OF THE MANDIBLE (FIG. 239)

If sound teeth are present in the existing portion of the mandible, a prosthetic appliance can be constructed and inserted without great difficulty. For adequate stability, it can be clasped to the teeth which are present.

If the mouth is edentulous, a prosthetic device in the form of a lower denture must be joined to the upper denture by metal springs on either side, as is illustrated in figure 239. This arrangement is much more satisfactory than would be anticipated.

When the greater portion of the mandible has been lost, prosthesis invariably is most unsatisfactory from a functional standpoint, but some patients will wear the devices to improve their facial appearance.

This subject is discussed further on page 447.



Fig. 240.—Text on page 447.

PROSTHETIC APPLIANCES TO RESTORE THE GREATER PORTION OF THE MANDIBLE (FIGS. 240 and 241)

When the entire mandible, or the greater portion of it, is lost, the soft tissues of the chin and cheeks are badly scarred and distorted. They must be freed by an intra-oral incision which leaves a large raw pocket. This pocket must be lined with a thin, shaved skin graft, as was discussed on pages 441 and 443.

There is no method of constructing a good prosthetic device for an extensive defect of this type. In figure 240, a prosthetic appliance to restore the greater part of the mandible is illustrated. In addition to metal springs, a vertical bar on each side is necessary to maintain the lower prosthetic appliance in correct alinement with the upper denture. Such a device cannot be expected to function very successfully because an insufficient portion of mandible is left to operate the large prosthetic appliance during mastication. Many ingenious prosthetic devices, which are helpful in individual cases, have been prepared, but there are no general rules to be followed in construction of these restorative appliances.

For a few days after an appliance such as is illustrated in figure 240 has been put in place, the lower lip, which is stretched and tense, has a tendency to contract downward. Elastic bands attached, at their lower ends, to a strip of adhesive tape which covers the chin and lower lip, and, at their upper ends, to strips of adhesive tape which hang from a head dressing and lie along the cheeks, will elevate and stretch the lip to overcome this shortening and retraction (fig. 241). This elastic traction to the lower lip need be used only for a few days. However, six months is required for the muscles of the lower lip to develop sufficiently to impart to the lip a natural contour.



Fig. 241.—Text on page 447.



Fig. 242.—Text on page 451.



Fig. 243.—In actual practice, the prosthetic appliance does not come in contact with the maxilla but with the tissue which overlies it. Text on page 451.

Loss of a Portion of the Upper Jaw, Requiring an Intra-oral Skin Graft and Intra-oral Prosthesis (Figs. 242 and 243)

COMMENTS AND TREATMENT

When a portion of the upper jaw is lost through trauma or secondary osteomyelitis, the resultant defect can be corrected only by means of intra-oral prosthesis. Following loss of a part of the upper jaw, such as is illustrated in figure 242, the overlying soft tissues of the cheek usually are scarred, retracted and distorted. Before a prosthetic device can be inserted to restore the lost portion of the maxilla, the scarred tissues of the cheek must be freed by an intra-oral incision. This procedure leaves a raw surface which must be lined with a thin, shaved skin graft, usually obtained from the inner surface of the thigh.

If teeth are present in the uninjured part of the upper jaw, the skin graft can be placed about a stent which is immobilized by a cast silver splint similar to the one illustrated in figure 235. If the mouth is edentulous, then the skin graft must be placed on a stent made of dental compound, similar to that illustrated in figure 238. Regardless of what type of stent is employed for immobilization of the skin graft, the graft should not be disturbed for ten days.

About two weeks following insertion of the skin graft, the prosthetic appliance can be constructed and can be introduced into the mouth (fig. 243). The type of prosthesis to be employed for this purpose depends largely on the number of upper teeth present; this is purely a dental problem with which we are not concerned in this book. If the mouth is edentulous, a prosthetic appliance in the form of an upper denture must be joined to the lower plate by metal springs on either side, as is illustrated in figure 239.

Not infrequently, loss of a portion of the uper jaw is associated with loss of the overlying tissues. Under these circumstances, the lost portion of the cheek usually is reconstructed by plastic measures before the prosthetic device has been prepared; however, in certain instances it is advantageous to insert the prosthetic appliance first, in order to prevent flattening and retraction of the reconstructed cheek.

Illustrations on pages 454 and 456.

THE TRANSPLANTATION OF CARTILAGE NECESSARY IN TREATMENT OUTLINED IN PROBLEMS 57, 58, 59 and 60 (FIGS. 244 and 245)

Cartilage is one tissue which lends itself to transplantation exceedingly well, and which can be employed to advantage for correction of some residual deformities that result from trauma of the facial bones. Of inestimable value is the discovery, made in recent years, that cartilage can be transplanted successfully from one individual to another, and that it can be preserved for an indefinite period in aqueous antiseptic solutions maintained at icebox temperatures. These facts, as applied to plastic surgical procedures, permit utilization of costal cartilage obtained under sterile conditions at necropsy. As is well known, preserved cartilage when cut retains its shape because it has undergone a spontaneous process of fixation which has destroyed its elasticity.

In spite of the fact that cartilage obtained at necropsy has been employed for implants with much success in a large series of cases at the Mayo Clinic, it is the opinion of members of the Section on Laryngology, Oral and Plastic Surgery at the clinic that fresh, autogenous, cartilage grafts are preferable. The one great disadvantage in the use of fresh cartilage transplants is their tendency to undergo distortion by warping, which is most objectionable. When fresh costal cartilage is employed as an implant to correct a facial defect, such as a receding chin, a saddle back deformity of the nose, or a flattened cheek of traumatic origin, it is most disconcerting and not unusual to discover postoperatively that the graft has curled to such an extent as to interfere with the desired cosmetic result.

However, a method has been evolved by Dr. G. B. New and one of us (JBE) by which the physical nature of fresh cartilage can be rapidly altered; thereafter, any inclination to bend which it might have possessed will no longer exist. The surgeon may then proceed to cut and shape the cartilage with no fear of subsequent distortion. This method consists of heating and cooling fresh costal cartilage in order to prevent a finished implant from warping. The technic of this method is as follows:

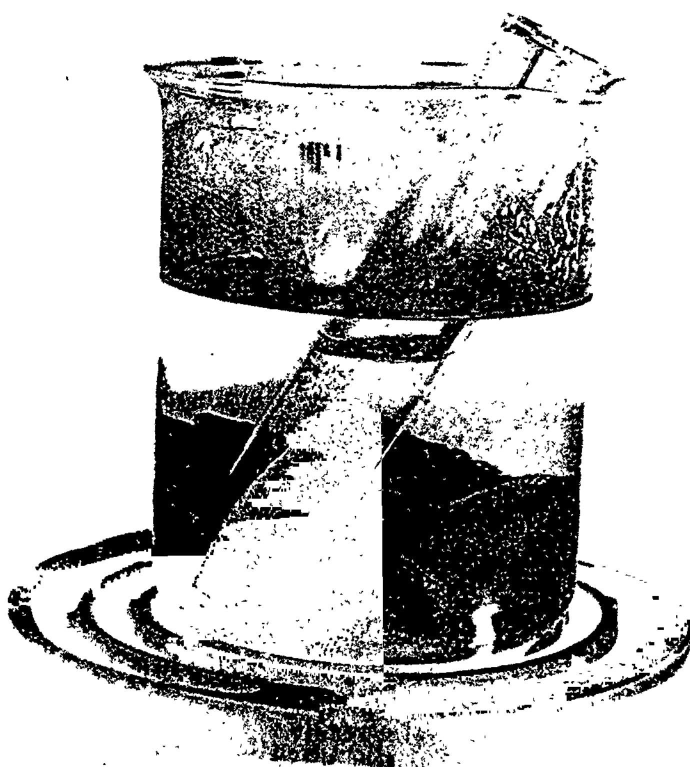


Fig. 244.—Text on page 455.

TRANSPLANTATION OF CARTILAGE (*Continued*)

Curing the Cartilage (Fig. 244).—After a full-thickness section of cartilage has been obtained from one of the patient's ribs, the piece is introduced into a sterile test tube (fig. 244) into which is poured sufficient aqueous solution of sodium ethyl mercurithiosalicylate (merthiolate) completely to cover the fragment of cartilage. The tube then is placed in a beaker of water which is allowed to boil for ten minutes (fig. 244). Although not essential, it is advisable that the bottom of the beaker be covered with several layers of gauze. When the cartilage is removed from the test tube, it is immersed, as a final step, in cold, sterile physiologic solution of sodium chloride for at least fifteen minutes.

Heating fresh cartilage brings about quick fixation. However, cartilage subjected to heating will undergo, on cooling, a certain amount of warping. Consequently, it is of the utmost importance that heated cartilage be allowed to cool before it is cut to the desired shape. In performance of any plastic procedure in which a cartilage implant is used, the aforementioned technic for preparation of the tissue need neither consume additional time during the operation nor demand extra work on the part of the surgeon. After a section of cartilage has been obtained from a rib, the surgeon may proceed immediately to preparation of the operative field of the facial defect, while a nurse heats and chills the cartilage and the assistant surgeon closes the incision in the thoracic wall. With few exceptions, the defect of the face can be fully prepared for reception of the implant by the time the treated cartilage has been made available for cutting and proper shaping. Some surgeons object to excision of costal cartilage for use in cosmetic operations, but no complications or ill-effects secondary to such excision have been encountered at the Mayo Clinic. Naturally, the selection of ribs from which such cartilage is to be taken is of considerable importance. We never attempt to remove cartilage from the left side of the thoracic wall and, on the right side, we prefer to obtain cartilage from the seventh rib. The technic of removing costal cartilage for grafting is described on page 457.

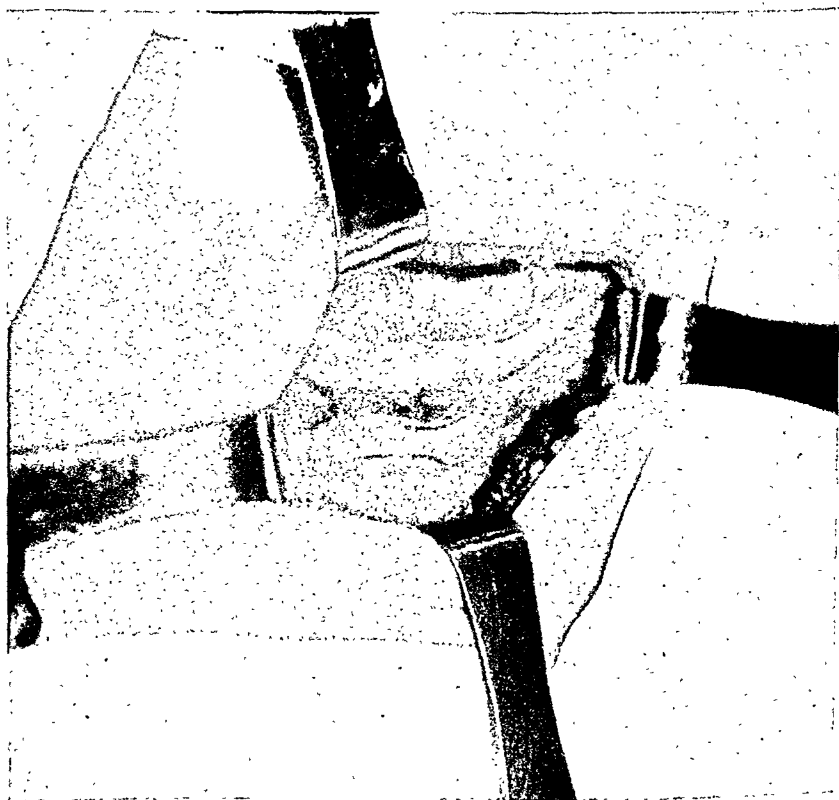


Fig. 245.—Text on page 457.

TRANSPLANTATION OF CARTILAGE (*Continued*)

Technic of Removing Costal Cartilage for Grafting (Fig. 245).—An oblique incision in the skin, extending from the center of the sternum, just above the xyphoid process, to the lower border of the thoracic cage in the region of the right midclavicular line will produce excellent exposure. When the attachments of the pectoralis major and the oblique and rectus abdominis muscles have been severed, the cartilaginous portion of the right sixth and seventh ribs (which unite anteriorly with the sternum) and the cartilaginous part of the eighth rib (which joins the costal cartilage of the seventh rib) are effectively uncovered (fig. 245). In the majority of instances, the cartilage of the seventh rib is least difficult to procure and it supplies an amount of material which is adequate for the average implant. We always take the full thickness of a rib and remove the section subperichondrially. If a large graft is required, cartilage from the sixth rib can be used as well. A columellar post, which is essential to correction of certain nasal deformities, can be constructed from the narrow, cartilaginous portion of the eighth rib.

Incidentally, unused pieces of cartilage should not be discarded; instead, they can be preserved in an aqueous antiseptic solution in a refrigerator. This stored material is extremely valuable for use in repair of a large defect in a subsequent case, a circumstance in which the maximal amount of cartilage that could be obtained from the patient himself would be insufficient fully to correct the deformity. This stored cartilage also can be employed to correct tiny facial defects, to obtain material for repair of which resection of a patient's own rib would constitute an operation of a seriousness disproportionate to the need.

In cutting a section of costal cartilage to the proper shape, a scalpel is all that is required. It is advantageous to have lead patterns of the facial defect to furnish the surgeon with specific measurements when he is cutting and shaping the implant.



Fig. 246.—Text on pages 459 and 461.

Loss of the Lower Border of the Anterior Part of the Mandible, Necessitating a Cartilage Graft for Reconstruction of the Chin (Figs. 246 and 247)

COMMENTS AND TREATMENT

Loss of the lower border of the mandible near the symphysis can result from a bullet or shrapnel injury (fig. 246) or from other trauma; the loss of bone may be directly due to the injury itself or to secondary osteomyelitis. This defect does not affect continuity of the alveolar arch but produces a flattened or receding chin. Such a facial deformity can be corrected by use of a costal cartilage implant.

If this type of bony defect is associated with loss of the adjacent soft tissues, plastic reconstruction of the chin may mask the deformity produced by the loss of bone. Whether or not such is the case, reconstruction of the soft parts of the chin should be completed before a cartilage implant is inserted to rebuild the contour near the symphysis.

For reconstructing a defect of the lower border of the mandible near the symphysis, some surgeons recommend ivory or celluloid because such material can be cut with great precision and ease before the operation. However, we do not favor use of foreign materials. A bone graft can be utilized but it is difficult to cut to the desired shape and it will not withstand infection. Consequently, we believe that cartilage offers the best material for correction of this type of deformity.

Before attempting reconstruction of the chin by means of a cartilage implant, it is advisable to obtain a plaster impression of the patient's face. From this impression, one can prepare a wax model on which the chin can be built to proper proportions in modeling clay. Such representation of the portion of the chin to be constructed gives a clear conception of the amount of bone or cartilage that will be required. Moreover, it permits of preparation of lead patterns, which furnish the surgeon with specific measurements when cutting and shaping the implant.

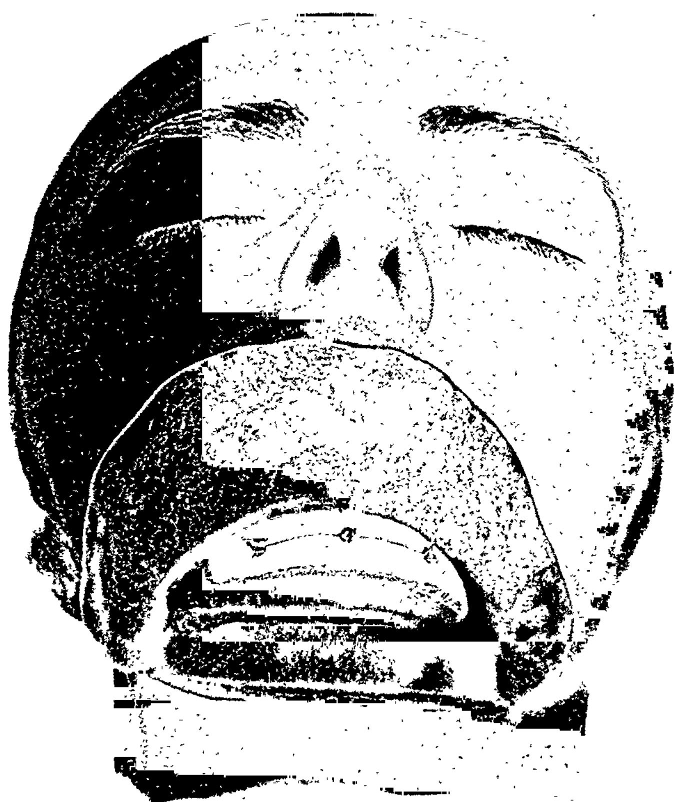


Fig. 247.—Text on page 461.

Our patients who require cartilage grafts for reconstruction of a receding chin are given general anesthesia. We administer nitrous oxide, oxygen and ether through an intratracheal tube. The necessary amount of cartilage is procured from the chest and is heated and cooled to avoid subsequent warping (page 455. If the defect of the chin amounts to nothing more than slight recession, only a small incision in the skin of the submental region is necessary. Working through this incision with blunt forceps or dissecting scissors, a pocket is created over the symphysis for reception of the graft. Such a minor defect of the chin can be corrected by a small graft which does not need fixation to the mandible. The implant is inserted over the symphysis, through the incision in the skin, and is immobilized in correct position by external pressure.

When the recession of the chin is more marked, a transverse incision is made through the skin of both submaxillary regions, about 2 cm. below the lower border of the mandible. By undermining the soft tissues the anterior portion of the lower jaw is exposed. Careful dissection is required to prevent nicking through the oral mucous membrane, which would be disastrous. In the majority of these cases a comparatively large graft is required; often, one thickness of cartilage is insufficient to correct the deformity fully. If such is the case, two pieces can be sutured together with fine catgut. While hemostasis is being established in the wound, the cartilage is cut to the desired shape and is adapted over the symphysis. Grafts of any appreciable size require internal as well as external fixation. Consequently, with a motor driven drill, three holes about 1 cm. apart are made through the cartilage and underlying bone (fig. 247). Through these holes is inserted a piece of heavy chromic catgut which, when tied, securely anchors the graft in position (fig. 247). The soft tissues then are sutured over the implant and the edges of the skin are approximated with sutures of fine black silk. To prevent collection of serum in the tissue spaces, a Penrose drain is inserted into the wound. External pressure is applied as a final step in the operation.

For consideration of the transplantation and surgical removal of costal cartilage, see page 457.



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For consideration of the transplantation and surgical removal of costal cartilage, see page 457.



Fig. 247.—Text on page 461.

Old, Depressed, Fracture of a Malar Bone Requiring a Cartilage Graft to Reconstruct the Contour of the Cheek (Fig. 248)

COMMENTS AND TREATMENT

As was discussed in chapter IV, some surgeons attempt refracture at the site of old, depressed fractures of malar bones, in an effort to restore them to their original position. However, in our experience, no procedure to refracture and elevate malar bones has proved successful. Instead, we prefer to reconstruct the contour of the cheeks by means of cartilage implants. Skin-fat-fascia transplants obtained from the outer aspect of the thigh have been used in place of cartilage, but it has been our observation that such soft tissue transplants do not prove very satisfactory because they will not withstand infection and because the fat frequently liquefies and becomes absorbed. Ivory, celluloid, vitallium or other foreign substances are not to be recommended for building up the contour of a flattened cheek due to an old fracture of a malar bone.

It is our opinion that a cartilage graft should not be applied over an old fracture of a malar bone until six months has elapsed from the time of the injury. If the plastic reconstruction is attempted sooner, the residual thickening and induration of the overlying soft tissues will interfere with the success of the surgical procedure.

Before attempting to reconstruct the malar region with a cartilage implant, it is advisable to obtain a plaster impression of the patient's face. From this impression, a wax or plaster model can be prepared, on which the cheek can be built to proper proportions in modeling clay. Lead patterns of the clay model then can be made, which furnish the surgeon with specific measurements when cutting and shaping a cartilage implant.

The patient is anesthetized with nitrous oxide, oxygen and ether administered through an intratracheal tube. The necessary amount of cartilage is procured from the chest, and is heated and cooled to avoid subsequent warping (page 455).

In preparing, over the malar region, the pocket into which the cartilage implant is to be inserted, it is well to make the

Illustration on page 464.

skin incision in the temporal region; then, if serum forms about the graft, it will not affect healing of the line of incision. Consequently, a horizontal or oblique incision is made in the temporal region, above the hair line. Working through this incision with blunt forceps or dissecting scissors, the soft tissues are elevated away from the old, depressed fracture of the malar bone. This leaves a pocket into which the cartilage implant is inserted.

Frequently more than one piece of cartilage is necessary to reconstruct the contour of the cheek. Two pieces of cartilage can be sutured together with fine silk and cut to the desired shape, as is illustrated in figure 248. After the wound is perfectly dry, the finished implant is introduced into the pocket and firmly seated in the desired position over the depressed malar bone. The incision in the skin is sutured and the graft is immobilized by strips of adhesive tape applied to the skin externally.

If, after a few days, an excessive amount of serum collects about the cartilage implant, it is well to aspirate it through the cheek, with syringe and fine, hollow needle, under sterile conditions, daily for three or four days. In some instances, after all the swelling has disappeared, it will be found that the graft is too prominent in one or more places. Under these circumstances, further surgical interference should be deferred for three months or longer. After this length of time, the wound can be reopened safely and prominent parts of the graft can be cut away with a scalpel so that the contour of the reconstructed cheek will assume normal proportions.

For consideration of the transplantation and surgical removal of costal cartilage, see page 457.



Fig. 248.—The fine line on the superior surface of the graft represents the fine silk suture which holds together the two parts of the graft. Text on pages 463 and 465.

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For consideration of the transplantation and surgical removal of costal cartilage, see page 457.

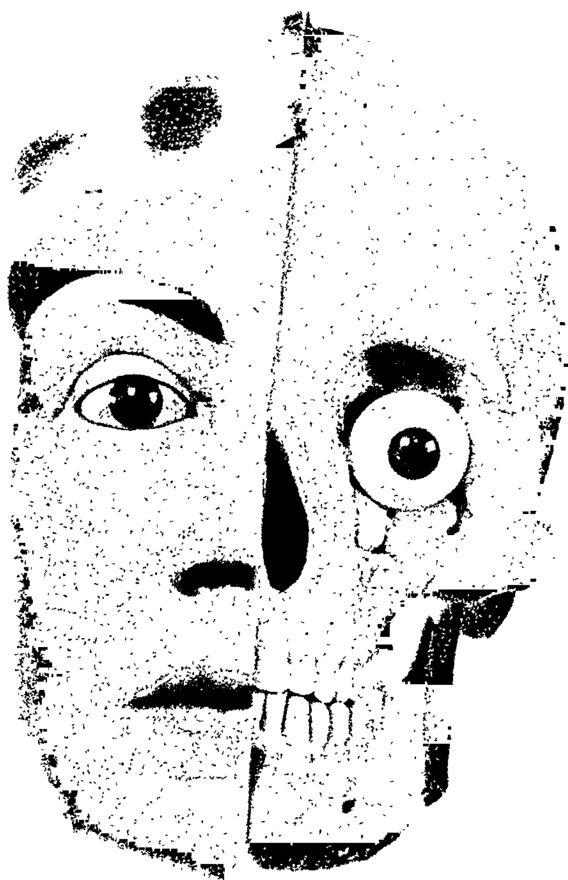


Fig. 249.—Text on page 467.

Old, Comminuted Fracture of a Malar Bone together with Comminution of the Floor of the Orbit, Requiring a Cartilage Graft to Elevate the Level of the Eyeball (Figs. 249 and 250)

COMMENTS AND TREATMENT

In a case of severe comminution of a malar bone associated with comminution of the floor of the orbit, the level of the eyeball may be displaced downward (fig. 249) and the attachment of the inferior oblique muscles is disturbed. The result of such an injury is a marked facial deformity and the patient complains of diplopia. As was discussed in chapter IV, attempts at intra-antral manipulation and reduction are not always successful. If such is the case, a cartilage implant inserted below the eyeball is the only available means of correcting the defect. This plastic procedure invariably improves, but rarely completely corrects, the condition.

If the eyeball is to be elevated by a cartilage implant, treatment should be deferred for three to six months following the injury, until the residual inflammatory thickening and induration of the soft tissues have disappeared.

At the time of operation, the patient is anesthetized with nitrous oxide, oxygen and ether administered through an intratracheal tube. The necessary amount of cartilage is removed from the chest and is heated and cooled to avoid subsequent warping and distortion (page 455).

For insertion of a cartilage implant along the floor of the orbit, it is well to make the incision in the skin along the inferior orbital margin. Working through this incision with a blunt elevator, the soft tissues are pushed away from the bony fragments along the floor of the orbit. If possible, the periosteum overlying the fragments should be elevated; special effort should be employed to elevate the periosteal attachment of the inferior oblique muscle. If the patient's diplopia is to be corrected, it not only is important to elevate the globe but it is equally important to elevate the attachment of the inferior oblique muscle.

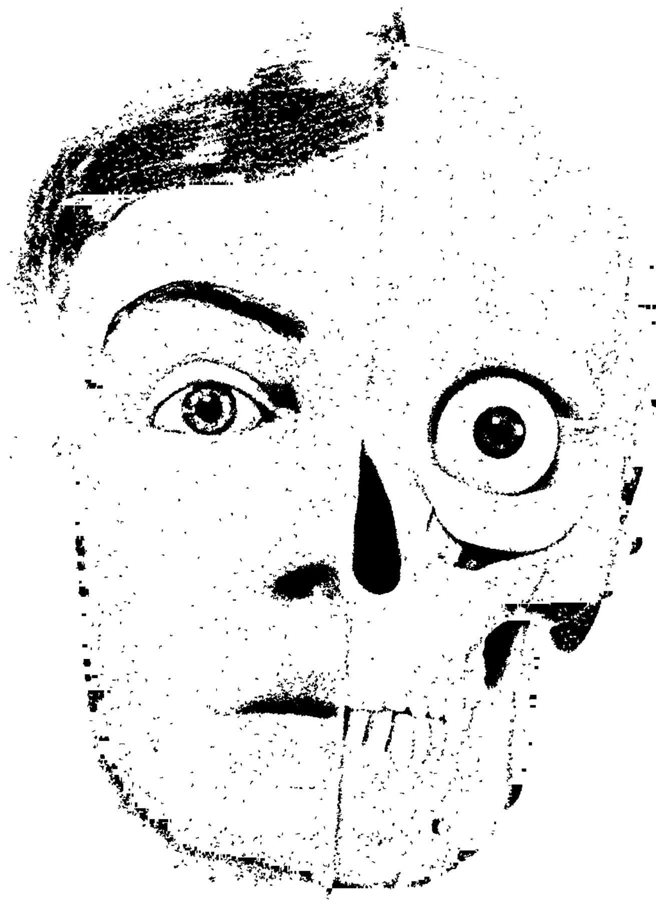


Fig. 250.—Text on page 469.

After the periosteum has been elevated, the piece of costal cartilage is carefully cut and shaped in such a manner that when it is inserted between the bony fragments of the floor of the orbit and the overlying periosteum, the eyeball is elevated to its proper level (fig. 250). The incision in the skin finally is sutured. Many technical difficulties arise during the course of this operation, and the success of the ultimate result cannot be predicted. However, if reduction of the comminuted fracture of the floor of the orbit does not adequately elevate the eyeball, this plastic operation is worthy of consideration.

For consideration of the transplantation and surgical removal of costal cartilage, see page 457.



Fig. 251.—Text on page 471.

Residual, Traumatic, Saddle Back Nasal Deformities Requiring a Cartilage Implant to Reconstruct the Bridge of the Nose (Figs. 251 to 255 Inclusive)

COMMENTS AND TREATMENT

Under ordinary circumstances, there should be little deformity following correct treatment of a simple fracture of the nose. However, if the nasal bones are severely comminuted and there is marked posterior displacement, some residual depression of the bridge may develop in spite of any appliances which are used in the primary treatment. These saddle back nasal deformities, we believe, are best corrected by means of a cartilage implant (figs. 251, 252 and 253).

Before undertaking transplantation of costal cartilage to correct a saddle back deformity of the nose, it is essential to make lead patterns of the nasal defect, to furnish the surgeon with specific measurements when cutting and shaping the implant. Two such patterns are necessary: one represents the length and width of the desired implant, and one, the outline of the defect from the lateral aspect.

If cartilage is to be obtained from one of the patient's ribs, general anesthesia is indicated. We prefer nitrous oxide, oxygen and ether administered through an intratracheal tube. The necessary amount of cartilage is resected from the chest and is heated and cooled to prevent subsequent warping (page 455). For consideration of the transplantation and surgical removal of costal cartilage, see page 457.

The piece of cartilage is cut to the desired shape by means of a scalpel. The lower end of the implant should be tapered to fit into the linear depression between the two lower lateral cartilages of the tip of the nose (fig. 251). Furthermore, the undersurface of the graft should be cut in a concave fashion, which is helpful in seating the graft over the nasal bridge and in preserving the desired shape of the implant.

In preparing the nose for reception of the cartilage implant, an incision is made in the skin along the lower border of the nostrils (fig. 254). Working through this incision with dissect-



Fig. 251.—Text on page 471.



Fig. 253.—Postoperative photograph of patient represented in fig. 252. Nasal deformity corrected by cartilage implant. Text on pages 471 and following.

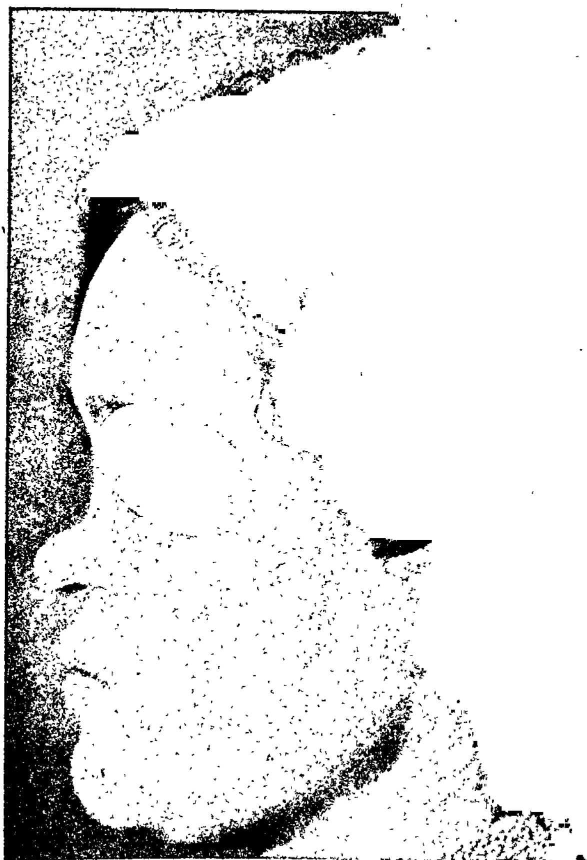


Fig. 252.—Traumatic saddle-back deformity of the nose. The patient stated that the fracture of the nasal bones was not treated at the time of the injury. Text on pages 471 and following.

ing scissors or a double-edged knife, the skin over the entire nose is undermined and freed from the underlying tissues. This leaves a subcutaneous pocket over the nasal bridge into which the cartilage implant is inserted. Some surgeons prefer to undermine the periosteum over the nasal bones so that the upper end of the graft can be inserted between the nasal bones and their periosteal covering; this aids in retaining the implant in proper position. Following these preparations, the implant is inserted through the skin incision (fig. 254). Finally, the line of incision is sutured. An external metal splint, to prevent formation of hematoma and to maintain the implant in proper position is held in place with adhesive tape (fig. 105).

In some individuals, very little normal tissue holds the two lower lateral cartilages of the nasal tip together in the median line. If such is the case, it is well to suture the cartilages together with two or three catgut stitches, as is illustrated in figure 254; this prevents the lower end of the cartilage implant from slipping down in between the two lower lateral cartilages and thus producing a depression of the middle third of the nose.

As has been discussed previously, the correction of many traumatic nasal deformities requires, in addition to a cartilage implant, other plastic procedures, such as refracturing the nasal bones. However, discussion of the plastic operations that are required to correct all of these various nasal deformities would require too many pages to be included in this book. Moreover, such operations are entirely plastic problems with which we are not concerned primarily here.

Occasionally, the tip of the nose lacks sufficient cartilaginous support to hold the lower end of the cartilage graft forward in proper position. Under these circumstances, a columellar post of costal cartilage is required (fig. 255). Such a post can be made from the cartilaginous portion of the eighth rib. The post is inserted into a surgically prepared subcutaneous tract in the columella and is seated over the spinous process of the maxilla. Above, the post supports the tip of the cartilage graft. The lower end of any cartilage graft must not be tapered at the margins if a post is required for support (fig. 255). The cartilage graft and the cartilage post are joined together by a silk suture. Some

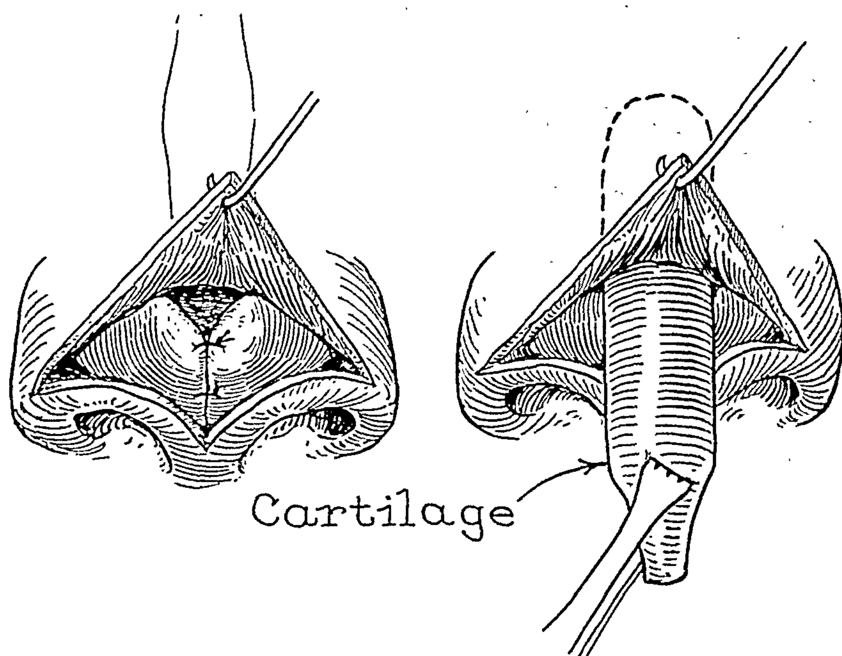


Fig. 254.—Text on pages 471 and 475.

surgeons prefer to prepare a cartilage graft and post both from the same piece of costal cartilage, leaving some of the overlying perichondrium attached to form a hinge for the two grafts.



Fig. 255.—Text on page 475.

CHAPTER X

CONSTRUCTION OF PLASTER HEAD CASTS AND DESCRIPTION OF APPLIANCES

CONSTRUCTION OF PLASTER HEAD CAST (FIGS. 256 TO 271 INCLUSIVE)

IT is our opinion that some of the appliances which we employ in the treatment of fractured facial bones can be fixed more firmly by use of a plaster head cast than by any other form of headgear. However, if stability of a head cap is to be attained, it must be built down over the mastoid processes. A head cast which is so loose that the patient can remove it himself is practically useless for retention of appliances.

HEAD CAST (FIGS. 256 to 271 Inclusive)

Our method of constructing a plaster head cast is described and illustrated chronologically in the following pages. Except for the manner in which we fashion the head cap over the mastoid processes, the technic of its construction is very much the same as that described several years ago by Ivy and Curtis.

With the exception of one set of circumstances, we never shave a patient's head prior to application of a plaster head cast. Long hair of women is braided into a knot on top of the head; this does not interfere with stability of the cast. However, if an individual has a flat or insignificant occipital prominence, a plaster head cast cannot be retained satisfactorily. Under these circumstances, we shave the back of the patient's head and apply a strip of sponge rubber ¼ inch (0.64 cm.) thick and measuring in width and length about 1 by 3 inches (about 2.5 by 7.5 cm.); this rubber is held in position by a narrow strip of adhesive tape. The friction exerted by the rubber that lies between the plaster cast and the head prevents displacement of the head cap

downward, with the result that an undue amount of pressure is applied to the forehead. In order to relieve the pressure of this portion of the head cast, we apply a strip of felt ¼ inch (0.64 cm.) thick to the forehead, with adhesive tape, before the head cap is constructed. After the cast has been completed, this piece of felt is removed, a space remaining between the cap and the skin of the forehead. By this procedure, pressure sores or necrosis of the region of the forehead is obviated.

Details.—The particulars of construction of the head cast are best read in association with the illustrations:

Figure 256.—A piece of stockinet 12 to 14 inches (about 30 to 35 cm.) long is pulled down over the patient's head to the chin. On drawing the stockinet upward for a distance of about 2 inches (about 5 cm.), the hair becomes directed upward, which is distinctly advantageous.

Figure 257.—A piece of bandage 2 inches (5 cm.) wide is tied loosely around the stockinet over the vertex of the head. Next, a nick is cut in the stockinet just above the knot of the bandage. Through this small opening in the stockinet are tucked the knot and loose ends of the 2 inch bandage. As is illustrated in the next figure, this bandage can be employed as a draw string to tighten if necessary the head cap when completed.



Fig. 256.—Text on page 481.



Fig. 257.—Text on page 481.

Figure 258.—The upper, free portion of the stockinet should not be turned down over the head at this stage. However, in this illustration, it has been pulled down to show how the piece of 2 inch bandage can act as a purse string to draw the stockinet taut over the head.

Figure 259.—Four strips of felt, ¼ inch thick, are applied vertically so as to cover the two frontal prominences and the two parietal regions. The strip of felt over each parietal region should be carried down toward, but not over, the mastoid process. These felt pads are retained in position with adhesive tape and are essential in relieving pressure on those regions of the head which are subjected to the greatest amount of pressure by the plaster head cast.

If a transverse strip of felt is applied across the forehead to relieve the pressure of a head cast to which traction wires are attached, as described on page 481, the two vertical strips of felt over the frontal prominences should be omitted. Furthermore, the strips of felt in the parietal regions may be dispensed with if sponge rubber is used over the occipital prominence. See page 479.

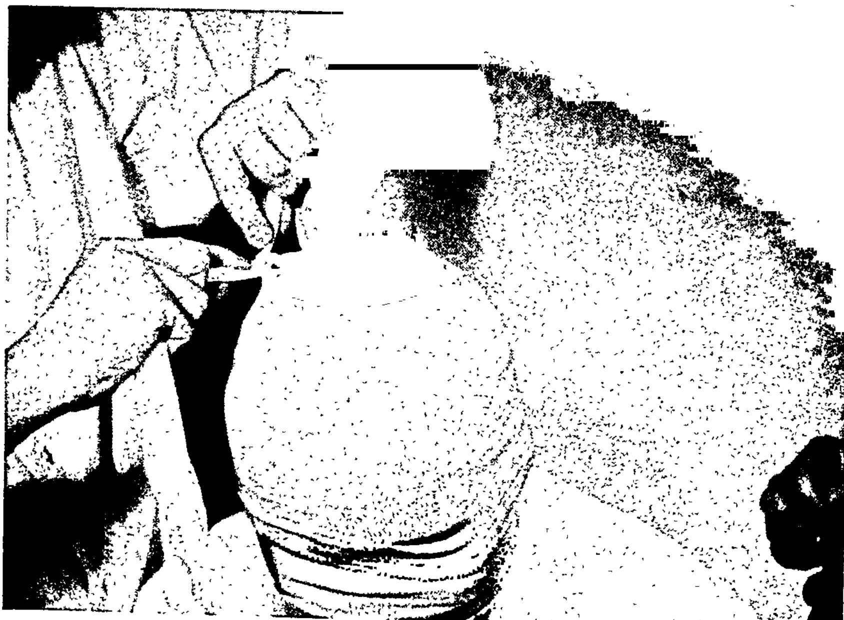


Fig. 258.—Text on page 483.



Fig. 259.—Text on page 483.

Figure 260.—The upper, free end of the stockinet is pulled down as a cuff to cover the four felt pads.

Figure 261.—It is advisable to draw a line with an indelible pencil or skin pencil on the stockinet at the proposed lower border of the head cast. It is our opinion that the lower edge of the cap should be located at the eyebrows anteriorly and just back of the ears laterally, so that the cast will cover the mastoid processes completely and will extend well down below the occipital protuberance posteriorly. This line drawn on the stockinet facilitates applications of the plaster bandage to the correct lower level.



Fig. 260.—Text on page 485.



Fig. 261.—Text on page 485.

Figure 262.—Plaster bandage dipped in water is applied to the head over the stockinet, care being taken not to carry the plaster down below the line which has been drawn on the stockinet. Two or three thicknesses of plaster bandage are adequate. At this stage, plaster bandage need not be conveyed over the mastoid processes. While applying the plaster bandage, the surgeon should dip his hands in water frequently in order to provide moisture for any dry plaster still present in the bandage; this procedure insures an even distribution of wet plaster throughout the head cap.

Figure 263.—A roll of wet plaster bandage is folded back and forth on a table so as to form eight or nine layers of bandage about 1 foot (30 cm.) in length. As is illustrated in the next figure, this strip, consisting of several layers of plaster bandage, is employed to cover the back of the head and mastoid processes.



Fig. 262.—Text on page 487.

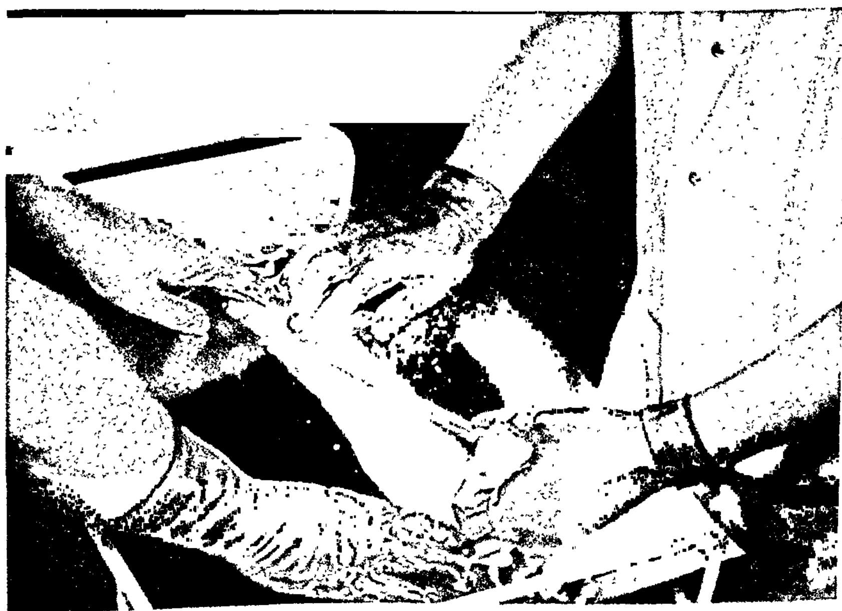


Fig. 263.—Text on page 487.

Figure 262.—Plaster bandage dipped in water is applied to the head over the stockinet, care being taken not to carry the plaster down below the line which has been drawn on the stockinet. Two or three thicknesses of plaster bandage are adequate. At this stage, plaster bandage need not be conveyed over the mastoid processes. While applying the plaster bandage, the surgeon should dip his hands in water frequently in order to provide moisture for any dry plaster still present in the bandage; this procedure insures an even distribution of wet plaster throughout the head cap.

Figure 263.—A roll of wet plaster bandage is folded back and forth on a table so as to form eight or nine layers of bandage about 1 foot (30 cm.) in length. As is illustrated in the next figure, this strip, consisting of several layers of plaster bandage, is employed to cover the back of the head and mastoid processes.

Fig. 264.—Text on page 489.



Fig. 265.—Text on page 489.

Figure 264.—The layers of plaster bandage just prepared are placed over the back of the head and over the mastoid processes. The line which was drawn on the stockinet aids in determining how far down to place these layers of plaster bandage. It is advisable manually to work the wet plaster of these layers of bandage into the plaster of the bandage previously applied over the head.

Figure 265.—The excess of plaster bandage over the ears is cut away just behind the ears with scissors. The remaining plaster bandage over the back of the head then extends over the mastoid processes just to the cephalo-auricular angles. This is the only satisfactory method of applying plaster bandage over the mastoid processes which we have discovered. By the other method, in which plaster bandage is wrapped around and around the head, it is impossible to cover the mastoid regions without extending the plaster over the ears.

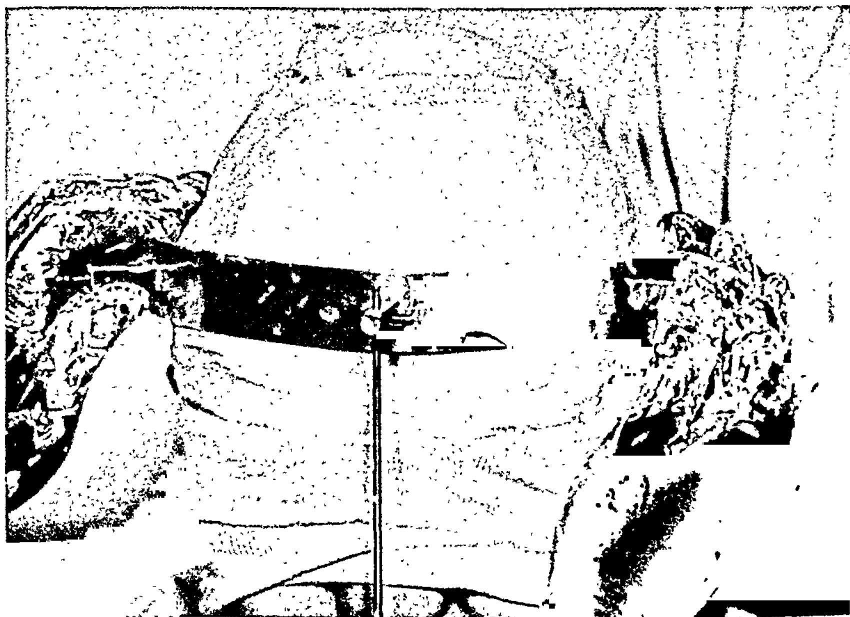


Fig. 266.—Text on page 491.

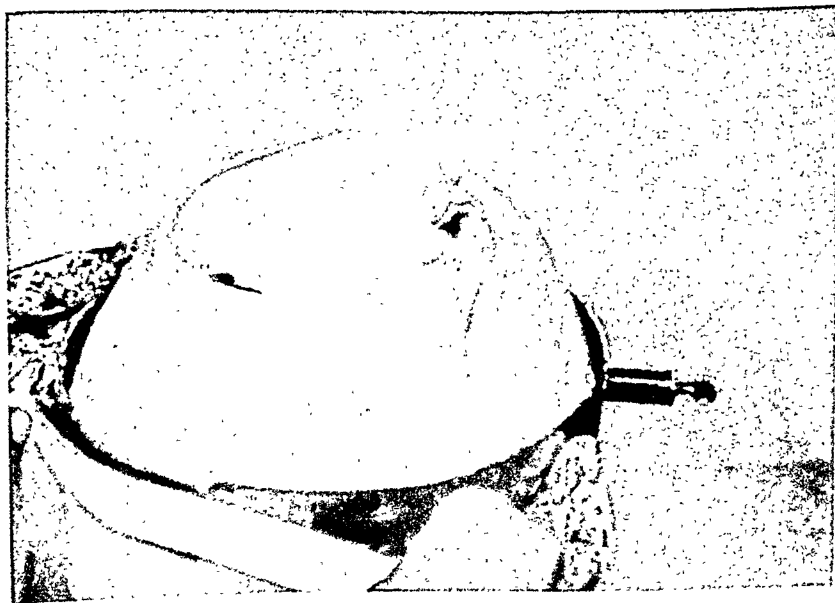


Fig. 267.—Text on page 491.

Figure 266.—At this stage in construction of the head cast, the metal head band which has three posts for attachment of the various appliances used in facial bone work is inserted. In placing this band over the head, it is well to insert a vertical rod in the central post to aid in centering the band properly. The lower anterior border of the head band should be situated about 1 inch (2.5 cm.) above the eyebrows.

If the condition requires a metal hook, to which a wire from the ramus of the mandible may be attached, it should be incorporated in the head cast at this stage (see fig. 303). Coat hanger wire is particularly suitable for construction of such hooks. One end of the wire is shaped to form a hook which emerges in the mastoid region; the other end of the wire should be bent to extend over, or around, the head for a distance of several inches. The assistant holds this wire in proper position over the head, while more plaster bandage is applied to embody it in the head cap.

Figure 267.—A piece of adhesive tape placed across the free posterior ends of the metal band retains the band in proper position until plaster bandage can be applied in order to incorporate the metal band in the head cap.



Fig. 268.—Text on page 493.



Fig. 269—Text on page 493.

Figure 268.—Another layer or two of plaster bandage is placed around the metal band to incorporate it in the head cast. The plaster in this bandage should be worked manually into the plaster previously applied.

Figure 269.—The lower, free edge of the stockinet is folded up over the head cap. In order that the stockinet may not cover the metal posts which emerge from the head cast, a vertical cut should be made through the stockinet at the site of each post; this enables one to fold the stockinet up around, rather than over, the posts. The folded up portion of the stockinet is embodied in the head cast by application of another layer of plaster bandage. Turning the lower end of the stockinet upward in this fashion effects a soft, nonirritating lower margin for the head cap.

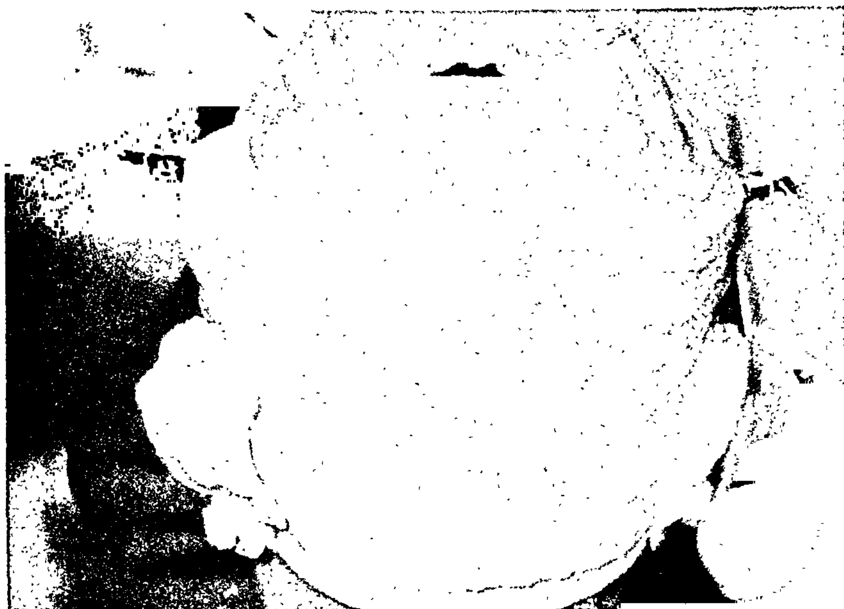


Fig. 270.—Text on page 495.

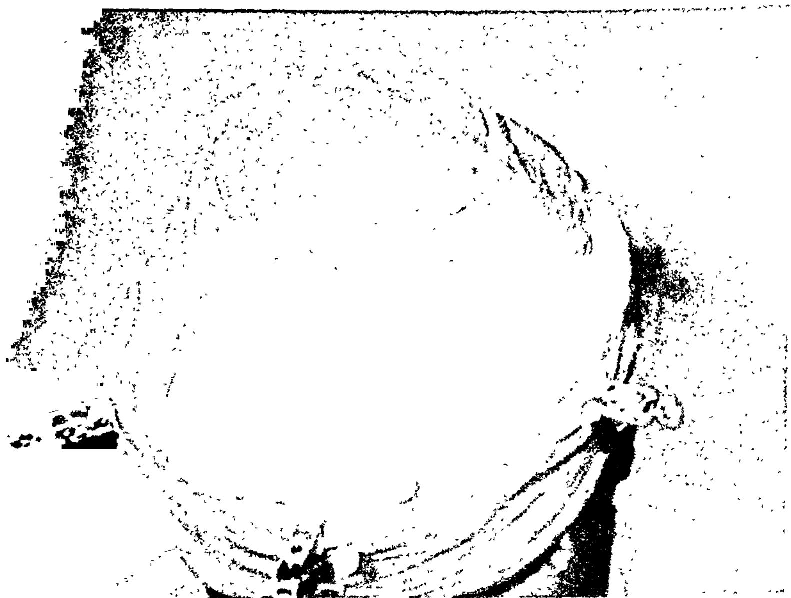
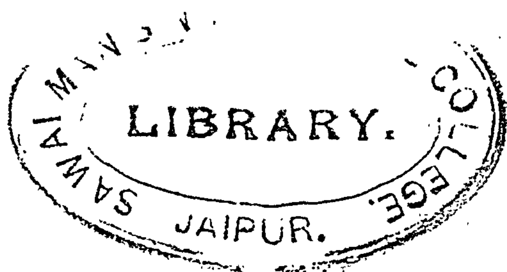


Fig. 271.—Text on page 495.

Figure 270.—The plaster head cast is now complete, having been constructed to fit securely over the mastoid processes for proper stabilization. Several hours are required for the plaster to dry thoroughly. Due to movements of the patient's head, it is likely that the wet plaster will be pushed away from the mastoid processes before it has set completely. To counteract this tendency several layers, or a wad, of gauze should be applied to those portions of the completed, wet plaster cast which cover the mastoid processes; then if the gauze is bandaged in place in the manner illustrated here, and is left in place for twelve to eighteen hours, until the plaster becomes thoroughly dry, the head cast will be found to be adapted perfectly to the mastoid regions. After twelve to eighteen hours, the gauze and bandage over the mastoid processes is removed.

Occasionally, the lower free edge of a plaster head cast which fits tightly over the mastoid processes will produce some irritation of the skin in these regions. If such is the case, a pair of pliers can be employed to break and bend over the free edge of the hard cap in order to remove this source of irritation to the skin.

Figure 271.—The completed, dry plaster head cast is illustrated. The gauze covering the large hole in the top of the cap should be removed at this stage; this gauze was inserted merely to keep plaster away from the patient's hair.



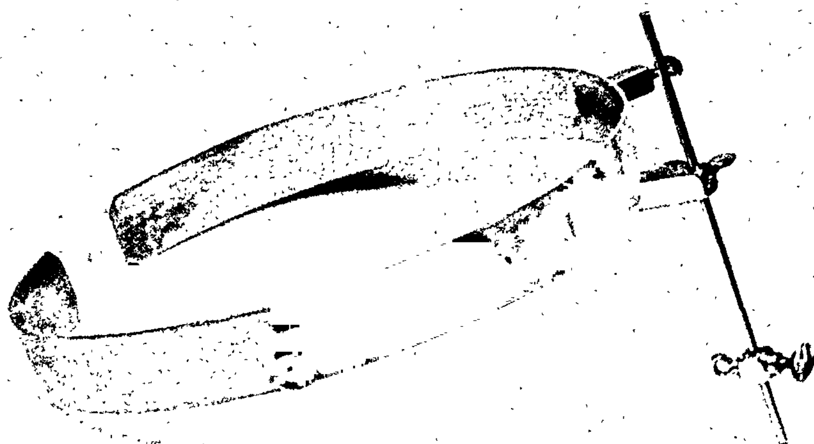


Fig. 272.—Text on page 497.

Head Band and Rod Attachments (Figs. 272 and 273)

The head band illustrated in figure 272 was devised by one of us (JBE) for immobilization of appliances needed in the treatment of fractured facial bones. It consists of a metal band ¾ to 1 inch (about 2 to 2.5 cm.) in width, and is made of aluminum that is sufficiently pliable to permit manual adaptation to the contour of any patient's head. Whether or not the extremities of this band meet posteriorly or whether they overlap on the patient's head is of no consequence. To the band, three metal posts are riveted. The two lateral posts are located about 4½ inches (about 12.5 cm.) from the central post. Each post possesses one or more perforations and thumb set screws for the reception and retention of appliances. All of these set screws should be tightened with pliers in order to insure absolute fixation of the attachments to the head band.

We favor the use of this type of head band because it can be quickly incorporated in a plaster head cast and will retain securely any of the appliances which we use in treatment of fractured facial bones. This band obviates the necessity of creating makeshift appliances or attachments for each patient.

The steel rod with adjustable hook (fig. 272), when inserted in the central post, can be employed as a source of attachment for rubber bands whenever elastic traction in a forward direction on a fractured facial bone is required. This rod can be inserted quickly in the central post of the head band, and does away with the necessity of embodying wires in the plaster head cast and of bending them to fit the individual patient.



Fig. 273.—Text on page 499.

The adjustable hooks to which traction wires for the upper jaw can be attached are mounted on a curved rod, the ends of which are retained by the lateral posts of the head band (fig. 273). These hooks can be shifted from side to side and can be rotated forward or backward. Following attachment of traction wires, the hooks can be so adjusted that there is no lateral pressure of the traction wires on the soft tissues of the cheeks. As was discussed on pages 171 to 173, traction wires which produce no lateral pressure cannot cut through the soft tissues to produce linear scars. However, such is not the case when traction wires are attached to fixed points on the head cast.

The end of each adjustable hook possesses a turnbuckle to which the traction wire is directly attached. Such turnbuckles, while not essential, are desirable because they offer a convenient and rapid method of changing the tension of traction wires or of taking up the slack which may occur in them.

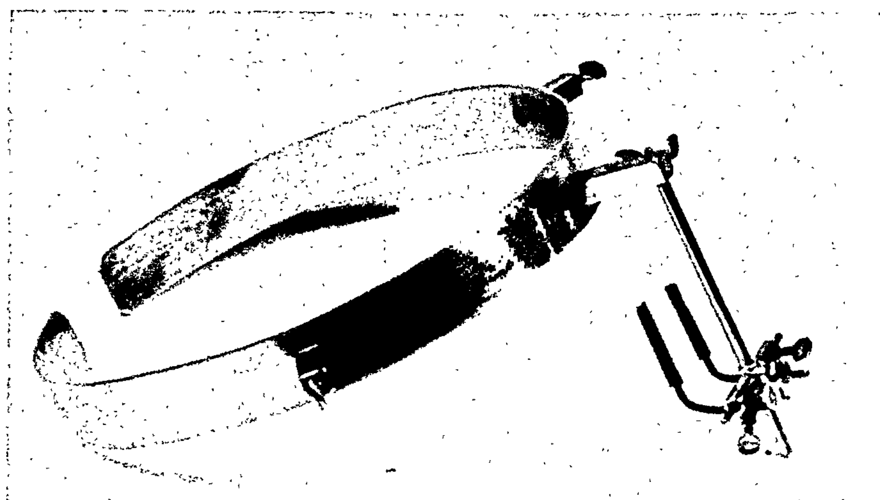


Fig. 274.—Text on page 501.

Head Band and Nasal Attachments (Figs. 274 and 275)

Figure 274 represents the nasal appliance devised by one of us (JBE) for immobilizing severely comminuted and depressed nasal bones in a desirable forward position. This appliance gains fixation by its attachment to the central post of the head band. The two wires, each covered with a rubber catheter, are inserted high in the nostrils, posterior to the nasal bones. These wires are inserted into clamps which rotate on a narrow, transverse rod. Each clamp possesses a thumb set screw for fixation of the clamp to the transverse rod, and another thumb set screw for fixation of the rubber covered wire to the clamp. The transverse rod which holds the two clamps is supplied with a thumb set screw for attachment to the central vertical rod of the appliance at any desired level.

All these thumb setscrews are essential in making the appliance adjustable and transferable from one patient to another. On rotation of the clamps, the wires which have been inserted behind the nasal bones can be brought forward to elevate them. On tightening the thumb set screws, the nasal bones are immobilized in this forward position.

In the use of any appliance which possesses so many movable parts, some difficulty always is encountered in attaching and adjusting the device on the patient. However, when once fastened in proper position, it offers an effective means of holding the nasal bones forward. Of more importance, it permits adjustments of the position of the nasal bones any time during the period of healing of the fractures.

This appliance must be retained in position for two weeks, until sufficient fibrous tissue has formed about the fractures to maintain the nasal bones in the desired forward position without mechanical aid. Any nasal appliance which possesses wires, which are inserted behind the nasal bones as is the case here, tends to widen the nose. Consequently, it must be replaced by another instrument to narrow the nasal bridge. See pages 502 and 503 and pages 245 to 249.

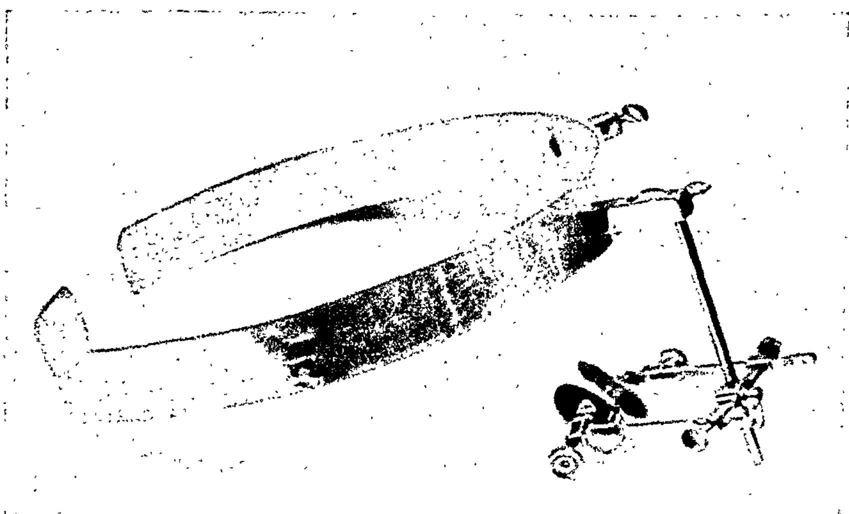


Fig. 275.—Text on page 503.

Following use of the first nasal appliance described on page 501, the apparatus illustrated in figure 275, which was devised by one of us (JBE), is employed to narrow the bridge of the nose.

This second nasal appliance gains fixation by its attachment to the central post of the head band, which is incorporated in the plaster head cast. It possesses two lateral, metal plates, cushioned with felt. The felt is attached to the pads with glue. By means of a screw device, each plate can be shifted mesially or laterally. The horizontal rods which support the plates, also can be moved forward or backward and can be fixed in position by a set screw. The appliance possesses, moreover, a transverse rod to which the lateral pads are indirectly attached; the transverse rod can be moved up or down on a central vertical rod. Thus, the appliance can be adjusted to the nose of any patient and, when the pads are adjusted to the sides of the nose, the bridge can be narrowed to any desired degree.

This instrument is extremely effective. If the bridge is extremely wide, it should be narrowed gradually by giving the screws to the lateral plates a few turns on two or three successive days. The appliance is retained in position for about two weeks, and, by its adjustability, the pressure over the nasal bones can be increased or decreased as seems desirable in order that the ultimate contour of the nose may be normal. See pages 252 to 255.

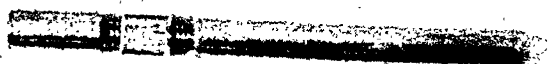


Fig. 276.—Text on page 505.

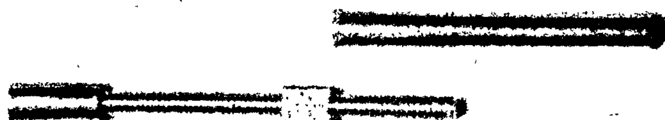


Fig. 277.—Text on page 505.

Orthodontia Jackscrews (Figs. 276 and 277)

An orthodontia jackscrew is a particularly valuable appliance for forcing the fragments of certain types of fractures apart and for temporarily retaining them in this separated condition (figs. 276 and 277). We employ such a jackscrew particularly to force the lateral fragments apart in certain cases of bilateral fracture of the anterior part of the mandible. See page 85. We also advocate the use of a jackscrew to force outward the loose fragment in a unilateral fracture of the upper jaw. See pages 196 to 201.

The jackscrew which we employ consists of a threaded rod on which a nut is mounted. One end possesses a fixed tubular sheath and the other a sliding tubular sheath. On rotating the nut clockwise, the tubular sheath is forced outward, thereby separating the bony fragments. Because the ends of the jackscrew are tubular, it is easily mounted between two pins which are attached to appliances fixed to the fragments.

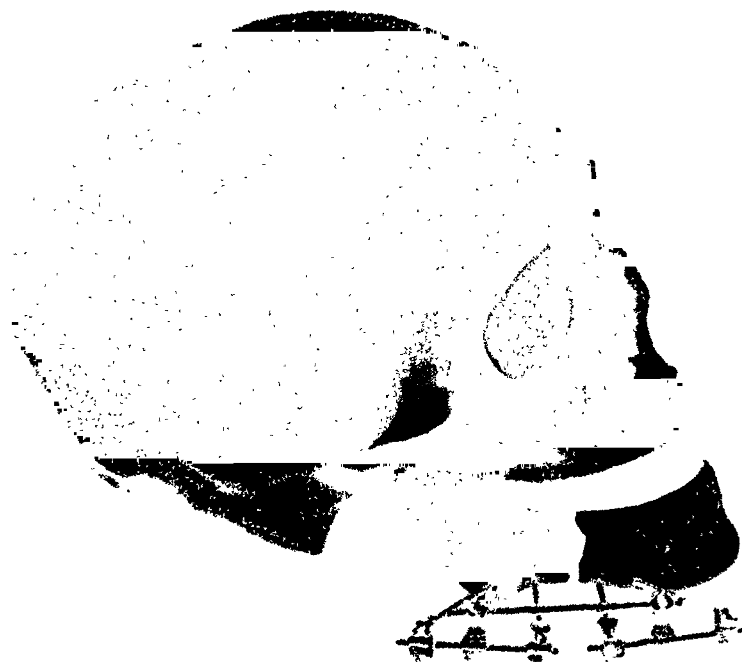


Fig. 278.—Text on page 507.

SKELETAL TRACTION AND FIXATION APPLIANCES (FIGS. 278 TO 286 INCLUSIVE)

The problems which arise in the use of external skeletal fixation have been discussed in chapter I, and the types of fractures which we believe are effectively immobilized by this form of fixation have been discussed in chapter II.

It is our opinion that external pin or screw devices, which produce external skeletal fixation, should not be employed when other, safer and more conservative methods of treatment will produce effective fixation of the bony fragments. In general, we employ skeletal fixation for immobilization of certain types of fractures of an edentulous mandible (fig. 278), but more particularly as a supplement to intermaxillary wiring. In a case of fracture near the angle of the mandible, an external pin fixation appliance is to be recommended for immobilization of the ramus, when the latter cannot be retained satisfactorily by other methods (figs. 279 and 280).

While we have employed mainly the Roger Anderson appliance, and find that it meets the requirements which we consider essential for external pin fixation, it is our opinion that most other appliances that produce external skeletal fixation are just as effective. We believe that the surgeon should use the appliance to which he is accustomed in order to obtain the most desirable results.

The technic of using external fixation appliances is discussed on pages 511, 513 and 517.



Fig. 279. —Text on page 507.



Fig. 280.—Text on page 507.



Fig. 279. Text on page 507.

The Roger Anderson appliance for external skeletal fixation consists of threaded pins (a in fig. 281), pin clamps (b in fig. 281), connecting rods (c in fig. 281), double clamps (d in fig. 282) and fixation rods (e in fig. 282).

In a case of fracture of an edentulous mandible, two pins are inserted at selected and divergent angles into each fragment. These pins should be placed in such a manner that they will not encroach on the line of fracture. Also they should be placed close to the lower border of the mandible so as not to enter the mandibular canal. After each pin has been inserted into the bone, an adjustable pin clamp is slipped over its end (fig. 281). The two pins are joined together by a connecting rod of proper length, which is slipped through the pin clamps and is fastened by means of the wrench illustrated in figure 283. This arrangement forms a two-pin unit (the so-called Frac-Sure unit).

If the two double-pin units are to be joined together by a fixation rod for immobilization of the bony fragments, a double-clamp should be slipped over each connecting rod before the rod is fastened to the pin clamps in each fragment; the double-clamp should be situated on each connecting rod, usually between the two-pin clamps. Following manual reduction of the fracture, and while holding the fragments in proper position, a fixation rod of proper length is slipped through the double-clamp of each unit and is securely fastened by means of the wrench represented in figure 283. See also figure 282.

The technic of inserting the pins and the care of the tissues surrounding the pins is described on page 513.

If this external fixation appliance is employed in conjunction with intermaxillary wiring to produce immobilization of the ramus in cases of fracture near the angle of the mandible (figs. 279 and 280), it is our opinion that one pin in each fragment is sufficient. In treating such a fracture, the skeletal fixation appliance furnishes merely the immobilization supplementary to that obtained by intermaxillary wires, which was mentioned on page 507. Consequently, two pins in each fragment are unnecessary to secure thorough fixation.

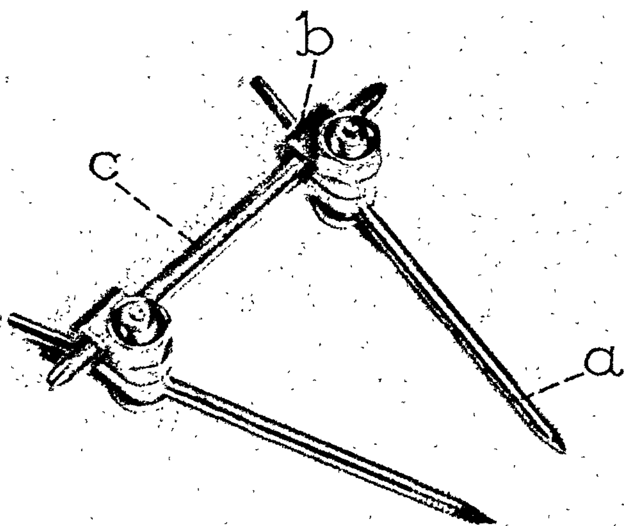
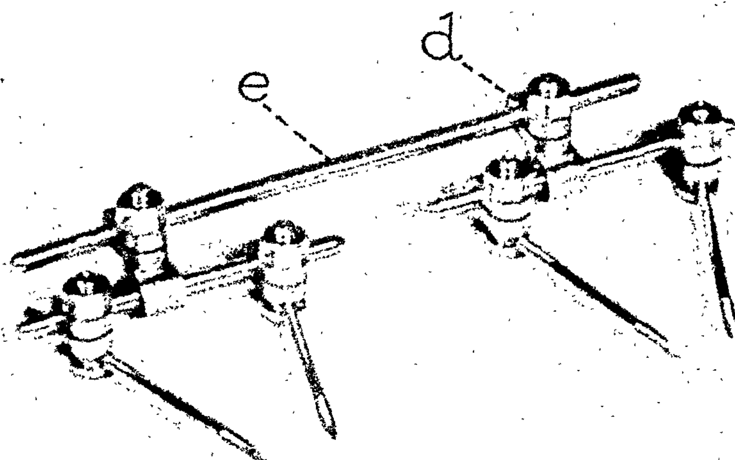


Fig. 281.—Roger Anderson two pin unit, a, threaded pin; b, pin clamp; c, connecting rod. For d and e see figure 282. Text on page 511.



The technic which we employ in using the Roger Anderson appliance is as follows: The skin overlying the injured side of the mandible is cleansed and painted with an antiseptic solution. Subsequently, the most rigid aseptic technic is employed during insertion of the pins. A small incision is made in the skin over the region of bone into which a pin is to be inserted. By blunt dissection, a tract is made down to the bone. The soft tissue walls of this tract are then held aside by small metal retractors while a hole is drilled all the way through the underlying bone. The drill point selected should be slightly smaller than the pin (we employ a number 53 drill point) and we recommend that the hole be made by means of a manually driven drill (fig. 283). The slowness by which such a drill is operated prevents an excessive amount of heat being developed in the bone surrounding the drill point. If an electrically driven drill is employed, it should be stopped frequently to prevent the development of too much heat, a factor favoring necrosis of the surrounding bone. The hole must be drilled at an angle which has been predetermined; ordinarily the hole should be made in an oblique direction rather than at right angles to the long axis of the mandible.

After the hole has been prepared, a pin is inserted into the hand drill holder illustrated in figure 283, which aids in turning the threaded pin into the hole. Care should be taken to rotate the pin inward just far enough to engage the internal plate of bone. It has been our experience that such pins are more secure and stable if they are inserted into a previously drilled hole than if they are worked directly into the bone by means of the hand drill.

Following the insertion of pins and the application of the various attachments, sterile dressings should be placed about the entire appliance, or at least around the pins, in an effort to prevent contamination of the wound surrounding each pin. If the pins are left in position for several weeks, it is advisable periodically to clip the beards of male patients with scissors. Particularly the hair in the skin surrounding the pins should be cut away; this is helpful in maintaining sterile pin wounds.

In cases of fracture near the angle, in which the anterior fragment is immobilized by intermaxillary wiring and the ramus is immobilized by skeletal fixation, we somewhat favor the use of

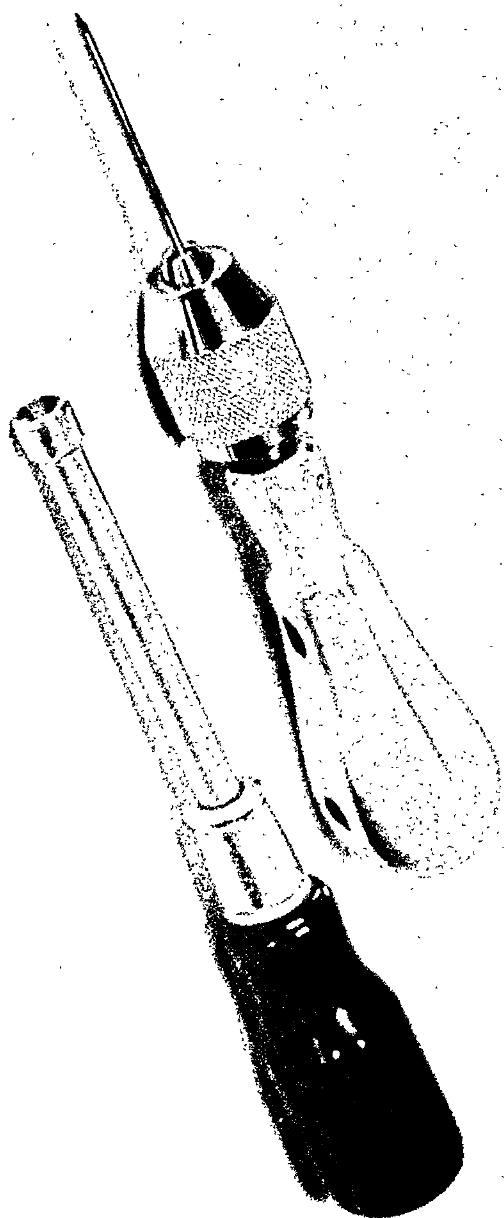


Fig. 253.—Instrument on the left is a wrench for tightening pin and double clamps; that on the right is a hand drill for insertion of pins into bone. Text on pages 511 and 513.

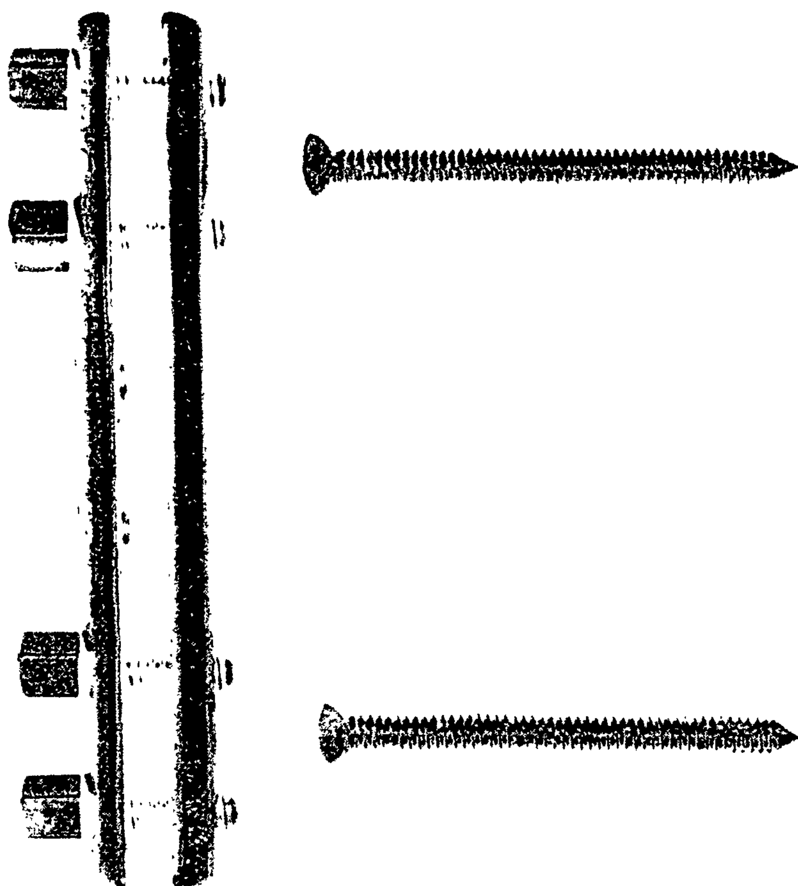


Fig. 285.—Text on page 517.

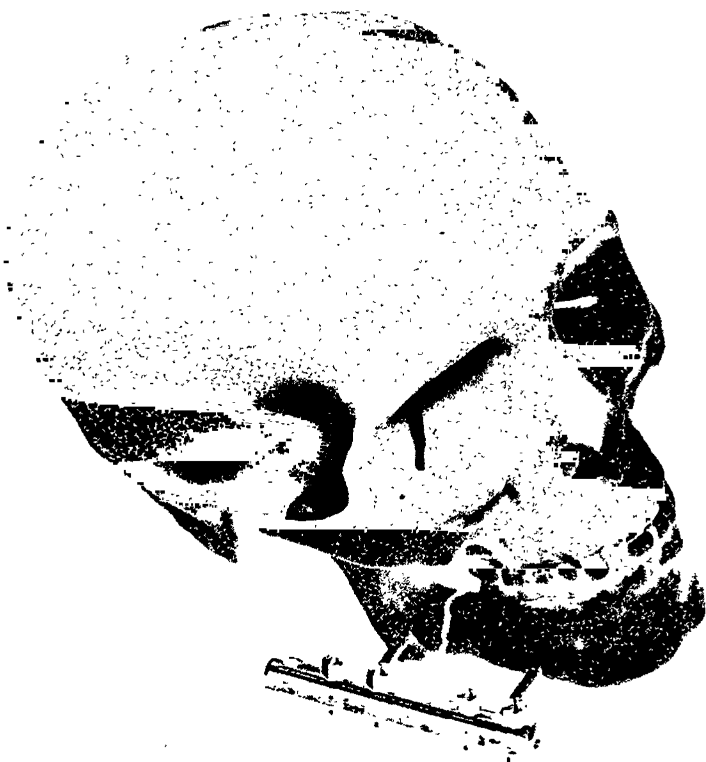


Fig. 284.—Text on page 517.

an external screw appliance such as is illustrated in figures 284, 285 and 286. With this appliance, we have had made vitallium screws which are inserted in a manner similar to that described on page 513. These screws, however, should be inserted at right angles to the long axis of the mandible. While these screws seem to be more stable when inserted in the bone than are smaller pins, the connecting apparatus lacks the adjustable qualities of the appliance previously described. For fractures of an edentulous mandible, the instrument illustrated in figures 284, 285 and 286 is not entirely satisfactory because a single screw in each fragment often is inadequate. Two pins inserted into each fragment provide a much more stable form of fixation.

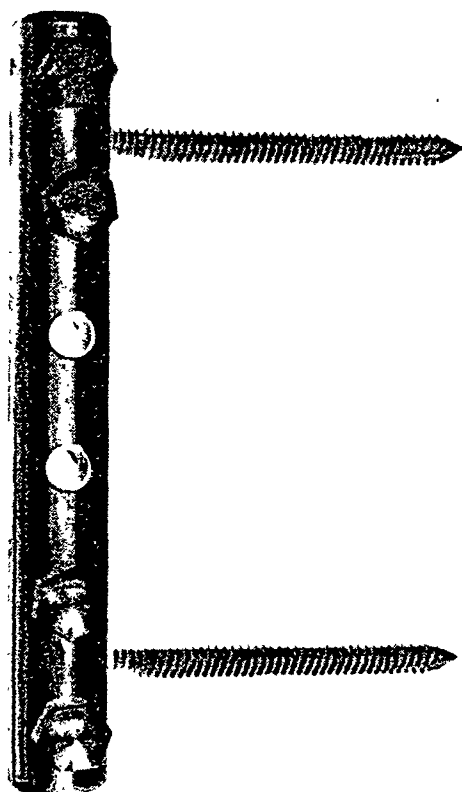


Fig. 286.—Text on page 517.

CHAPTER XI

INTRA-ORAL AND EXTRA-ORAL METHODS OF WIRING

FROM the standpoints of immobilization and occlusion, wiring still forms, and should form, the basis of treatment in a large percentage of fractures of the jaw. Various methods of interdental wiring are employed constantly, and wires are placed circumferentially around the mandible and are inserted through the soft tissues not infrequently. Except for continuous loop wiring, we use 26 gauge bronze or stainless steel wire for all purposes. For continuous loop wiring, however, brass wire probably is preferable because it is more rigid; consequently, the brass wire eyelets which are bent to form hooks will withstand a greater amount of elastic traction than eyelets constructed from other types of wire. Whenever wire is inserted into, or through, the soft tissues, we would like to stress again the importance of using bronze or stainless steel wire, which does not produce evident irritation of soft tissue; other wire, such as that made of brass or German silver, does produce an inflammatory reaction in the soft tissues and may lead to abscess.

Innumerable intra-oral and extra-oral methods of wiring have been suggested. All have definite good, and some bad, features. In this chapter, we shall include only those methods which we employ because, in our hands, they have proved the most satisfactory.

The intra-oral and extra-oral methods of wiring to be considered are:

1. Single loop (eyelet) and intermaxillary wiring.
2. Continuous loop wiring and intermaxillary elastic traction.
3. Hooked arch bars and intermaxillary elastic traction.
4. Use of orthodontia anchor clamp bands rather than wires around single biscuspid or molar teeth.



Fig. 287.—Text on page 523.

5. Attachment of arch bars to partially edentulous jaws.
6. Circumferential wiring of the mandible.
7. Traction wires inserted through the cheeks and extending from dental appliances to a head cast.
8. Traction wires inserted through the soft tissues, directly into bony fragments.



Fig. 287.—Text on page 523.

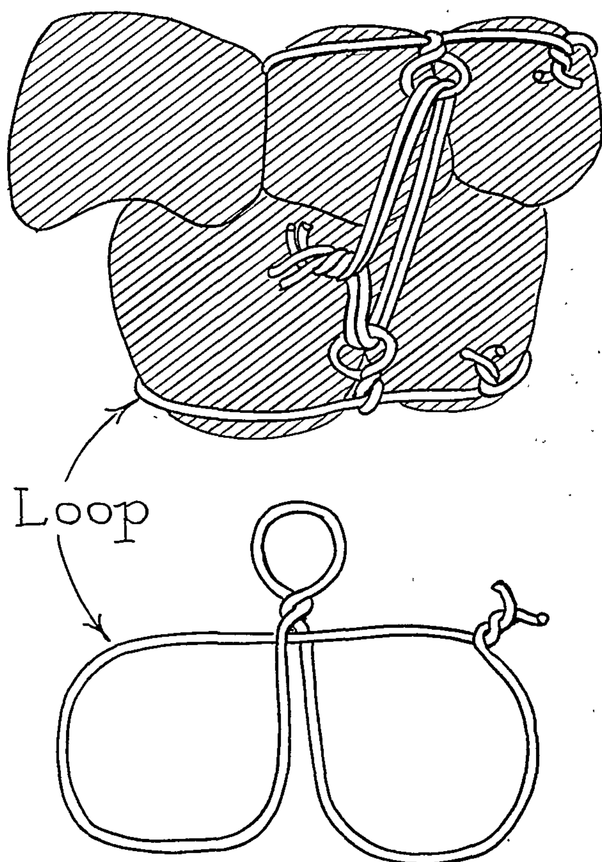


Fig. 288.—Text on page 523.

Single Loop (Eyelet) and Intermaxillary Wiring (Figs. 287 and 288)

Single loop (eyelet) and intermaxillary wiring (fig. 287) is a simple, rapid and effective method of immobilization for many types of fractures of the jaw. However, this type of wiring should not be used if patients are comatose, nauseated or vomiting because it necessitates holding the patient's jaws tightly together. When a patient is comatose, his tongue may block his airway and, if he vomits with a closed mouth, he may aspirate vomitus into the bronchi. The technic of this type of wiring is as follows (fig. 288):

A straight piece of 26 gauge bronze or stainless steel wire is bent in the middle and twisted once to form a single loop (eyelet). If this wire is to be attached, for instance in the bicuspid region, the two free ends of the wire are inserted between the biscuspid teeth and drawn lingually until the eyelet alone is visible on the buccal surface. One of the free ends of the wire is brought around the lingual surface of the first biscuspid tooth and inserted through the interproximal space mesial to this tooth. The other free end is drawn around the lingual surface of the second bicuspid tooth and inserted through the interspace distal to this tooth; on emerging buccally, this end of the wire is carried under the twist forming the eyelet, after which the two ends of the wire are twisted together.

Opposing wire loops should be placed on the upper and lower teeth. For immobilization of a short fragment, one set of opposing loops is sufficient but, for a long fragment, at least two sets are required.

After manual reduction of the fracture, the upper and lower wire loops (eyelets) are joined together by a double strand of 26 gauge bronze or stainless steel wire (fig. 288). If doubled, such intermaxillary wires are less likely to break when the free ends are twisted together and also are less likely to stretch during the period of immobilization of the fracture.



Fig. 289.—Text on page 525.

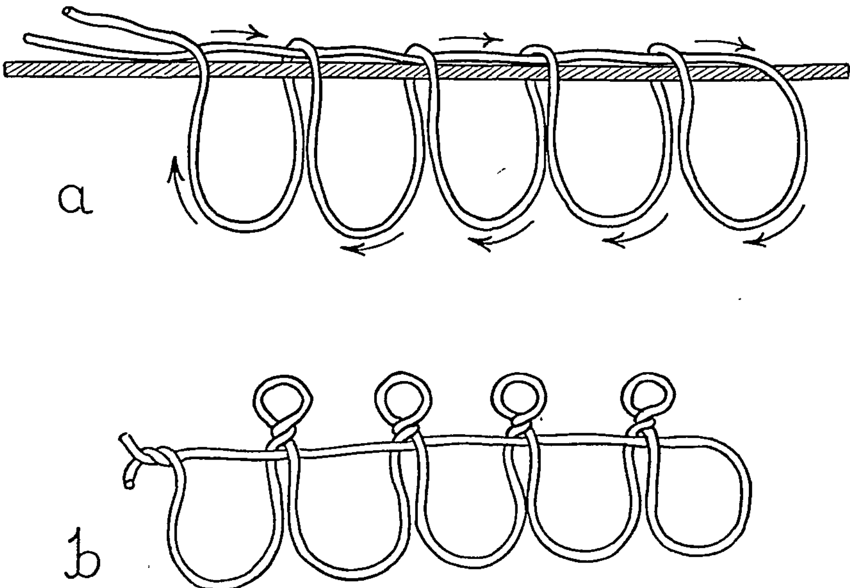


Fig. 290.—Text on page 525.

Continuous Loop Wiring and Intermaxillary Elastic Traction (Figs. 289 and 290)

Continuous loop wiring and intermaxillary elastic traction (fig. 289) can be employed for reduction and immobilization of some simple fractures of the mandible, particularly when it is not desirable to wire the patient's jaws tightly together. This is particularly true if the individual is comatose, nauseated or vomiting, as was explained on page 523.

The technic of this type of wiring is as follows: A long strand of 26 gauge brass wire is passed around several selected teeth in each fragment, as is illustrated in figure 290a. Along the buccal surface of these teeth is placed a section of 8 gauge lead wire; the brass wire is passed over this lead wire at each interproximal space to form loops in the brass wire. The lead wire later is withdrawn and each loop is twisted to form an eyelet, as is illustrated in figure 290b. These eyelets are bent toward the gum margin to serve as hooks. Similar continuous loop wires are placed around the opposing upper teeth. It is our opinion that a continuous loop wire never should be placed so as to cross a line of fracture.

Intermaxillary rubber bands are stretched between opposing eyelets (hooks) under a moderate amount of tension. These rubber bands not only can be employed to reduce the fracture but also can serve as a means of immobilization.

Fig. 291.—Text on page 527.

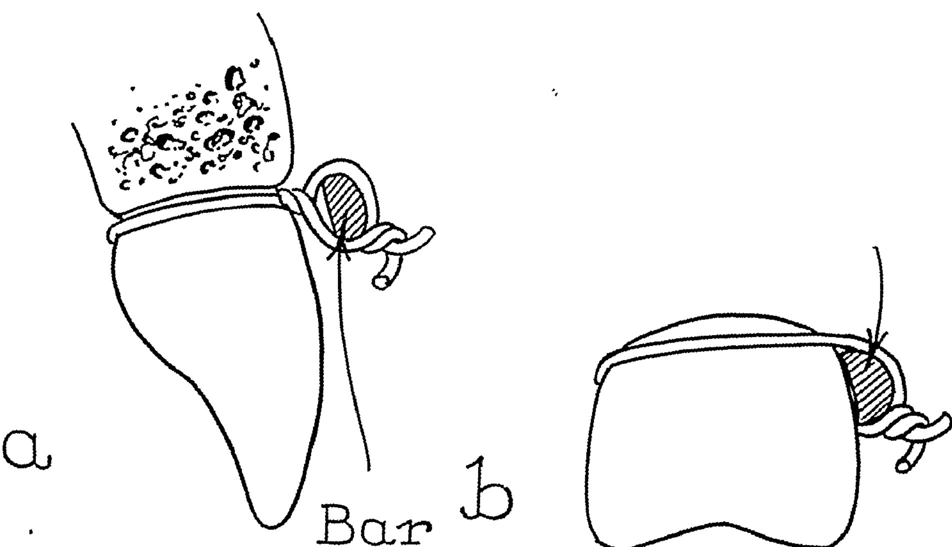


Fig. 292.—Text on pages 527 and 528.

Hooked Arch Bars and Intermaxillary Elastic Traction (Figs. 291 and 292)

Hooked arch bars and intermaxillary elastic traction (fig. 291) furnish the ideal method of reducing and immobilizing a great many different types of fractures of the jaws. The method is particularly desirable for impacted fractures and for those which are several days or weeks old. Under these circumstances, manipulation of the fragments is impossible and strong elastic traction is necessary for proper reduction of the fracture. Although proper attachment of arch bars to the teeth requires much time (the one disadvantage of this method), this procedure insures perfect dental occlusion.

The hooked arch bar which we prefer is a type devised by one of us (JBE). This bar, made of monel metal, is inexpensive; the hooks are formed in a punch press and later are bent over. This type of bar is pliable enough so that finger pressure alone will easily adapt it directly to the dental arch of the patient. Pliers and plaster models of the teeth are unnecessary in contouring the bar to the arch. Furthermore, the hooks never can break off and never impinge on the gum tissue.

We wire a hooked arch bar to every tooth in the fragment, from the first or second molar tooth forward, and employ 26 gauge bronze wire ligatures for this purpose. An arch bar can be wired to the teeth in one of two ways: The wires around each tooth can be twisted once before they are twisted over the arch bar (fig. 292a), or the wires can be twisted directly over the arch bar (fig. 292b). In the latter situation, the wires depend on the contact points between the teeth to prevent the bar from being pulled off, that is, in an incisal or occlusal direction. Under strong intermaxillary elastic traction, however, the contact points between the teeth may fail to retain the bar in proper position.

For adequate stabilization of an arch bar, we believe that a combination of the above two methods is desirable. Around each anterior tooth, a wire ligature (26 gauge bronze or stainless steel) is pushed over the singulum and is given three-quarters of a complete turn before it is twisted around the arch bar (fig.

292a). Such wires hooked over the singulum never can be pulled off the anterior teeth. The arch bar, however, has some vertical play which, on the relatively long anterior teeth, is of no disadvantage. On the posterior teeth, the wire ligature around each tooth is twisted directly over the arch bar (fig. 292b). If wires are twisted around posterior teeth before they are attached to the arch bar, considerable vertical movement (play) of the arch bar is allowed; at times, under these circumstances, the arch bar can be drawn in an occlusal direction sufficiently to interfere with articulation of the posterior teeth. However, if wire ligatures around the posterior teeth are twisted directly over the arch bar, the bar can undergo but little vertical displacement, even under strong intermaxillary elastic traction.

Although ordinarily it is advisable to ligate an arch bar to all of the teeth in the arch, or in the fragment, from the first or second molar tooth forward, if one or two teeth are badly malposed it is preferable not to wire the bar to these teeth. Furthermore, cuspid teeth, at times, due to their contour, will not retain wire ligatures satisfactorily. It is our opinion that an arch bar never should cross a line of fracture.

The numerous hooks present in the upper and lower arch bars permit the attachment of numerous intermaxillary rubber bands; they can be attached in various directions for proper reduction of the fracture. The intermaxillary elastic bands may be retained for immobilization of the fracture if the patient can be seen frequently during the period of healing of the fracture, so that rubber bands can be replaced when broken. Otherwise, in the absence of coma, nausea and vomiting, these rubber bands should be replaced by double intermaxillary wires passed over the arch bars rather than over the hooks of these bars. Intermaxillary wires never should be attached to the hooks of arch bars because, over a period of time, they may stretch sufficiently to slip off the hooks.

Use of Orthodontia Anchor Clamp Bands Rather than Wires around Single Bicuspid or Molar Teeth (Fig. 293)

The type of anchor clamp band which we prefer is illustrated in figure 293. The threaded bolt on the buccal side of this band is hollow and forms a sheath into which a round wire arch bar can be inserted. Furthermore, the buccal sheath serves as an

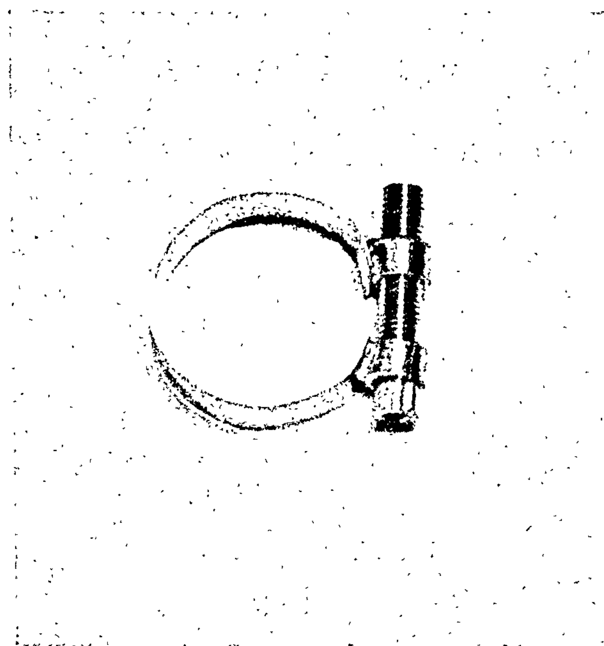


Fig. 293.—Text on this page.

excellent attachment for intermaxillary rubber bands or wires. A small, straight, pointed hemostat can be used to tighten the bolt of the clamp or a wrench specially designed for this purpose can be used.

Occasionally, the tooth to be banded may make very tight contact with an adjacent tooth; this tight contact may interfere with application of the band and, in certain instances, use of a tooth separator may be necessary before the band can be properly seated over the tooth.

These anchor clamp bands come in five sizes: small bicuspid, large bicuspid, small molar, medium molar and large molar. The medium molar type is the one which we employ most frequently.

292a). Such wires hooked over the singulum never can be pulled off the anterior teeth. The arch bar, however, has some vertical play which, on the relatively long anterior teeth, is of no disadvantage. On the posterior teeth, the wire ligature around each tooth is twisted directly over the arch bar (fig. 292b). If wires are twisted around posterior teeth before they are attached to the arch bar, considerable vertical movement (play) of the arch bar is allowed; at times, under these circumstances, the arch bar can be drawn in an occlusal direction sufficiently to interfere with articulation of the posterior teeth. However, if wire ligatures around the posterior teeth are twisted directly over the arch bar, the bar can undergo but little vertical displacement, even under strong intermaxillary elastic traction.

Although ordinarily it is advisable to ligate an arch bar to all of the teeth in the arch, or in the fragment, from the first or second molar tooth forward, if one or two teeth are badly malposed it is preferable not to wire the bar to these teeth. Furthermore, cuspid teeth, at times, due to their contour, will not retain wire ligatures satisfactorily. It is our opinion that an arch bar never should cross a line of fracture.

The numerous hooks present in the upper and lower arch bars permit the attachment of numerous intermaxillary rubber bands; they can be attached in various directions for proper reduction of the fracture. The intermaxillary elastic bands may be retained for immobilization of the fracture if the patient can be seen frequently during the period of healing of the fracture, so that rubber bands can be replaced when broken. Otherwise, in the absence of coma, nausea and vomiting, these rubber bands should be replaced by double intermaxillary wires passed over the arch bars rather than over the hooks of these bars. Intermaxillary wires never should be attached to the hooks of arch bars because, over a period of time, they may stretch sufficiently to slip off the hooks.

ATTACHMENT OF ARCH BARS TO PARTIALLY EDENTULOUS JAWS (FIGS. 294 AND 295)

Proper fixation of an arch bar to a partialy edentulous jaw may present difficulties if only a few teeth are present to which the bar can be wired. However, this problem can be easily solved by the use of anchor clamp bands having buccal sheaths and a round wire arch bar (fig. 294). Instead of employing ready made arch bars, we prefer to use brass wire, which can be cut to the desired length for each patient. This wire must be of a size which fits snugly into the buccal sheaths of the anchor clamp bands.

An anchor clamp band having a buccal sheath is attached to a selected bicuspid or molar tooth on each side of the jaw. The piece of brass wire to be used as an arch bar is bent with pliers and with finger pressure to conform to the contour of the dental arch. The ends of this wire are inserted into the buccal sheaths of the two clamp bands (fig. 295); the arch bar then is ligated to the teeth intervening between the banded posterior teeth. Whether the teeth which are ligated with 26 gauge bronze or stainless steel wire are anterior or posterior teeth, the ligature wire should be attached to the teeth and to the arch bar, as is illustrated in figure 292a. This arrangement produces such great stability of the arch bar that it can withstand a great amount of elastic traction without becoming displaced.

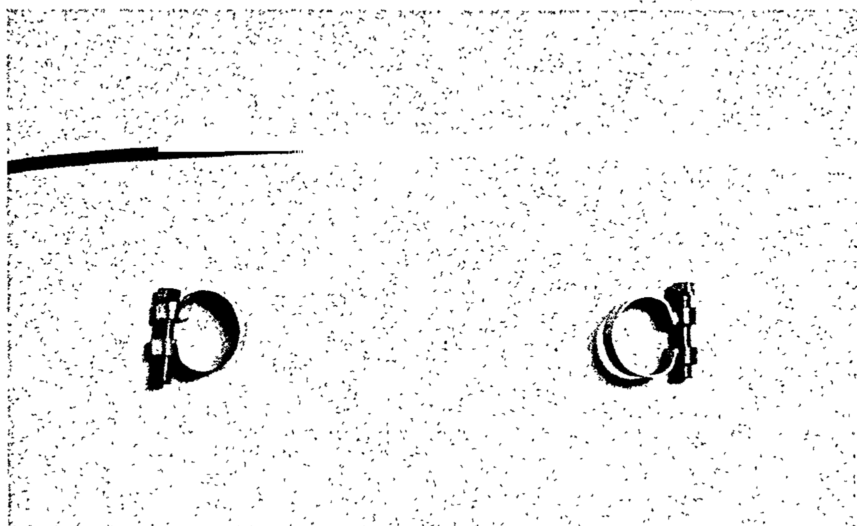


Fig. 294.—Text on page 531.

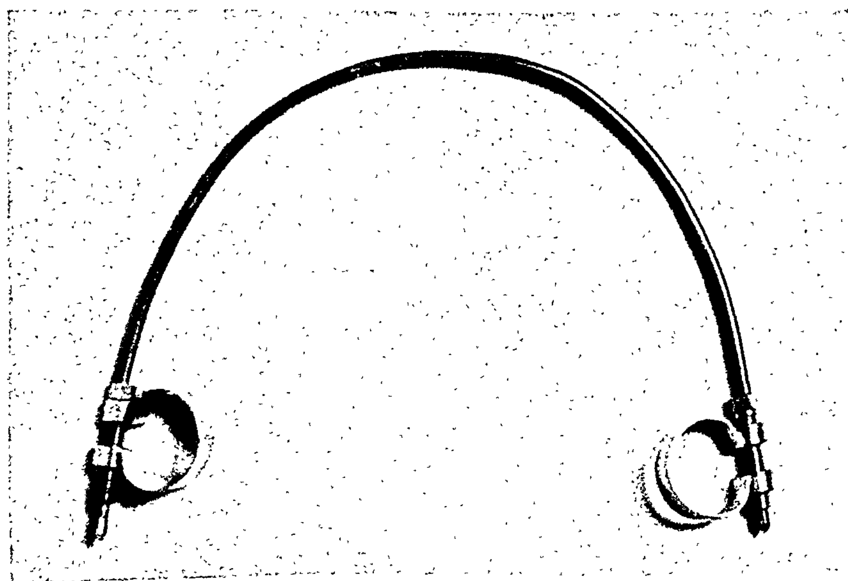


Fig. 295.—Text on page 531.

Attachment of Arch Bars to Partially Edentulous Jaws (Figs. 294 and 295)

Proper fixation of an arch bar to a partialy edentulous jaw may present difficulties if only a few teeth are present to which the bar can be wired. However, this problem can be easily solved by the use of anchor clamp bands having buccal sheaths and a round wire arch bar (fig. 294). Instead of employing ready made arch bars, we prefer to use brass wire, which can be cut to the desired length for each patient. This wire must be of a size which fits snugly into the buccal sheaths of the anchor clamp bands.

An anchor clamp band having a buccal sheath is attached to a selected bicuspid or molar tooth on each side of the jaw. The piece of brass wire to be used as an arch bar is bent with pliers and with finger pressure to conform to the contour of the dental arch. The ends of this wire are inserted into the buccal sheaths of the two clamp bands (fig. 295); the arch bar then is ligated to the teeth intervening between the banded posterior teeth. Whether the teeth which are ligated with 26 gauge bronze or stainless steel wire are anterior or posterior teeth, the ligature wire should be attached to the teeth and to the arch bar, as is illustrated in figure 292a. This arrangement produces such great stability of the arch bar that it can withstand a great amount of elastic traction without becoming displaced.

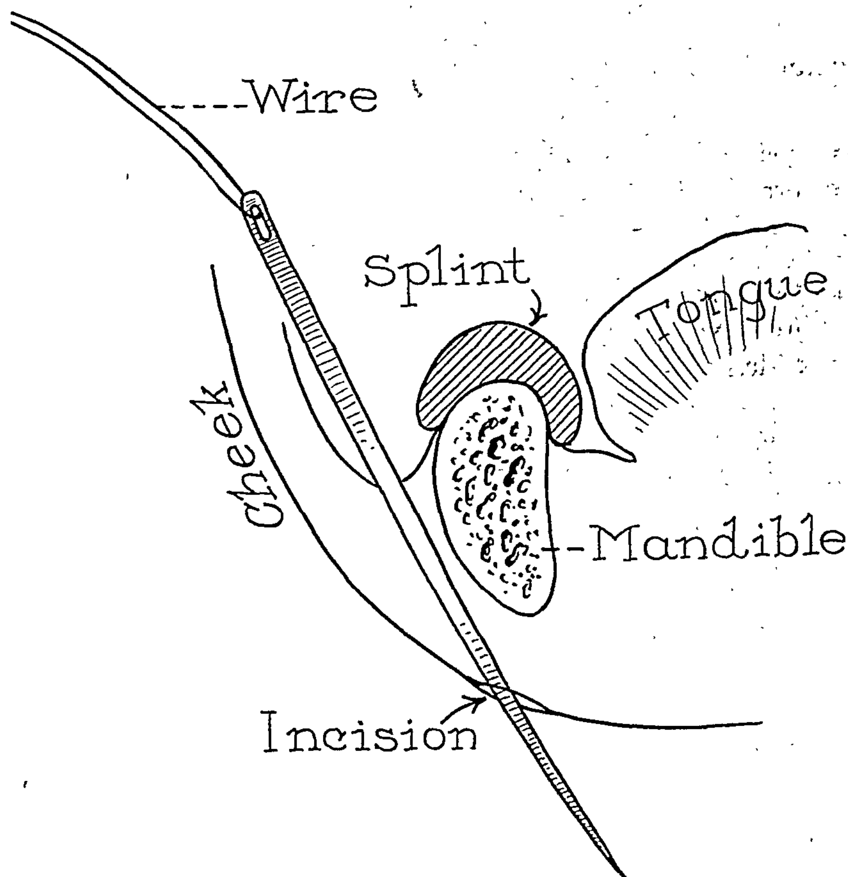


Fig. 296.—Text on page 533.

Circumferential Wiring of the Mandible (Figs. 296, 297 and 298)

As has been described under the headings of various problems in this book, circumferential wires for retention of acrylic or cast silver splints to the lower jaw are extremely important. Several technics for passing a wire around the mandible have been described. According to one technic, a ligature carrier is employed. By another technic, hollow needles are placed on either side of the mandible, so as to emerge in the submaxillary region, and through them the circumferential wire is threaded. It appears to us that it makes little difference what technic is employed; we prefer to use a very large, curved, cutting needle to carry the wire around the mandible because, in our hands, this has been the easiest and quickest method. The technic which we employ is as follows:

A long strand of 26 gauge bronze or stainless steel wire is threaded through a very large, curved, cutting needle so that a double wire trails the needle.

The needle is inserted through the alveolobuccal sulcus, with its concavity directed forward; that is, the concavity is not made to lie against the mandible on this downward thrust. The place for the insertion is opposite that portion of the mandible around which a circumferential wire is to be placed.

The needle is carried down through the soft tissues on the buccal surface of the mandible and out through a small incision in the submaxillary region (fig. 296).

Through this incision the needle is reinserted and is directed upward, with its concavity lying against the lingual surface of the mandible. It is carried up along this lingual surface, is pushed through the mucous membrane in the floor of the mouth, and is pulled out of the oral cavity with a needle holder (fig. 297).

By employing this technic, a double strand of wire surrounds the mandible and its ends are twisted over the dental splint (fig. 298). We believe that it is advisable to use double circumferential wires, because they will not break or stretch easily.

We stress again the importance of using bronze or stainless steel wire for circumferential wiring of the mandible. Brass or German silver wire irritates tissue and this may lead to formation of an abscess.

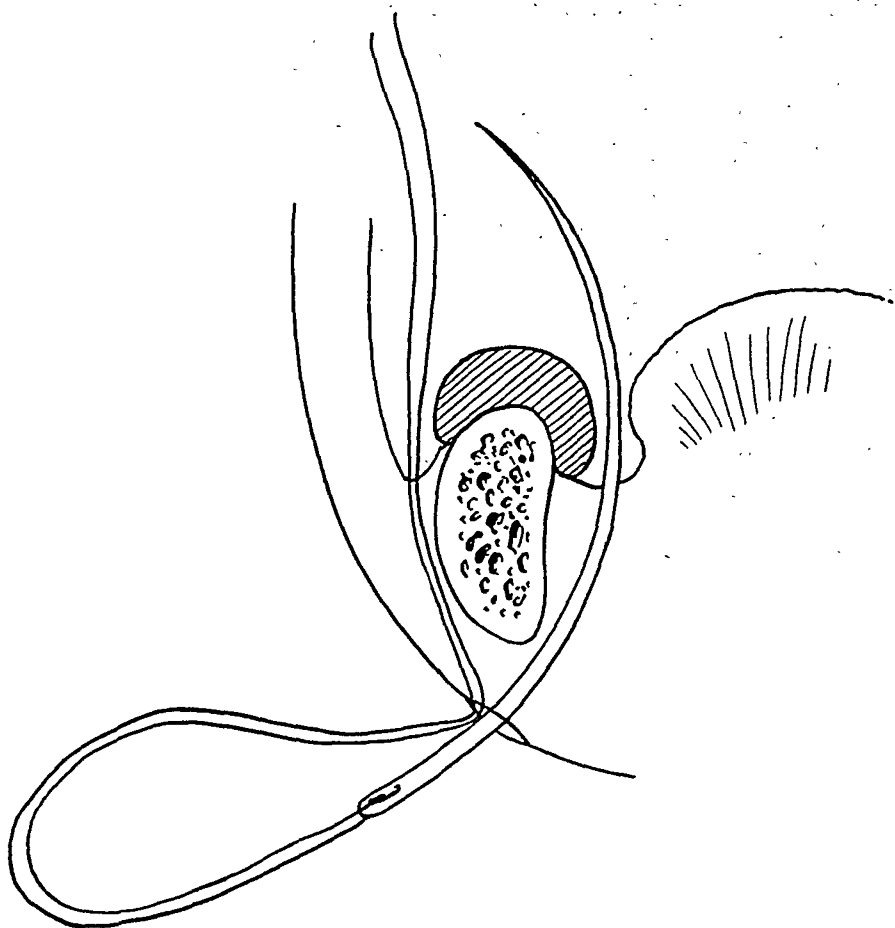


Fig. 297.—Text on page 533.

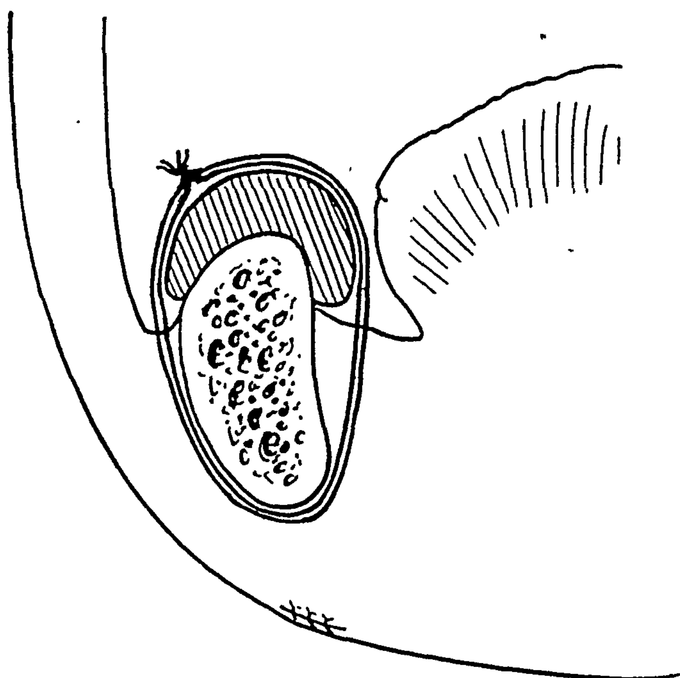


Fig. 298.—Text on page 533.



Fig. 299.—Text on page 537.



Fig. 300.—Text on page 5

Traction Wires Inserted through the Cheeks, and Extending from Dental Appliances to a Head Cast (Figs. 299 to 302 Inclusive)

METHOD OF INSERTION

Details.—The particulars of this procedure are best read in association with the relevant illustrations:

Figure 299.—Several methods have been described for insertion of traction wires through the cheeks. We believe that in the simplest technic, a long, straight, cutting needle is used. Through this needle is threaded a long section of 26 gauge bronze or stainless steel wire, so as to make a double strand of wire trailing the needle. Here again, it is important not to use brass or German silver wire, which irritates tissue. No harm can come from the use of bronze or stainless steel wire when it is inserted through the cheeks because such wire not only does not irritate tissue but acts as a through-and-through drain. The straight needle with the trailing wire is inserted into the cheek at any desired point.

Figure 300.—The straight needle is carried through the soft tissues of the cheek and is forced through the upper alveolobuccal sulcus, usually opposite the interspace between the second bicuspid and the first molar tooth. The needle then is brought out through the mouth, leaving a double strand of wire through the soft tissues of the cheek.

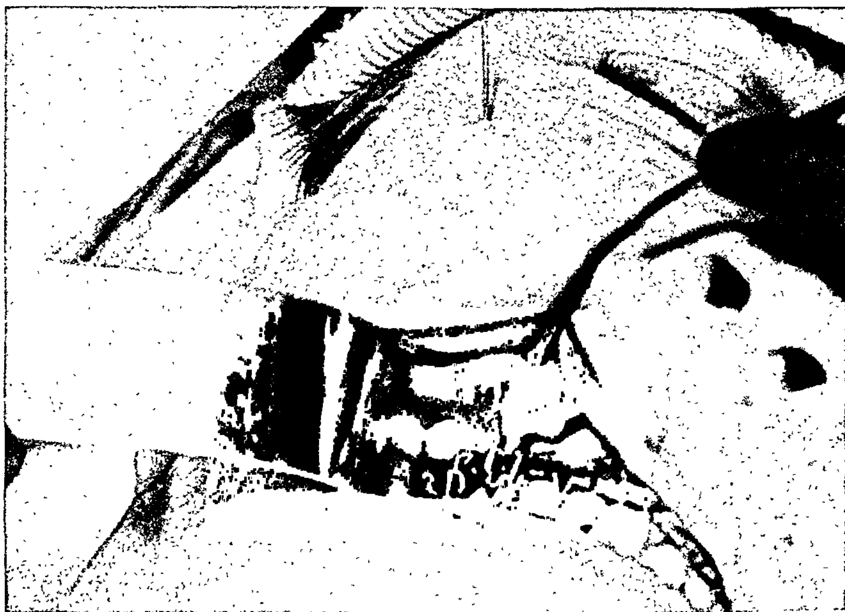


Fig. 301.—Text on page 539.

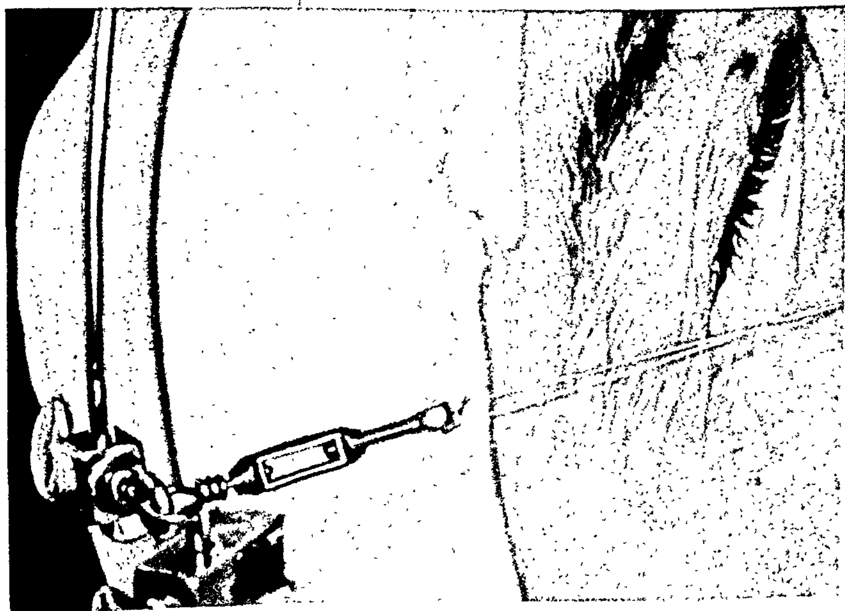


Fig. 302.—Text on page 539.

Figure 301.—At the lower end of the double strand of wire passing through the cheek, the needle is cut off. The cut ends of this double wire are twisted securely about the upper arch bar opposite the interspace between the upper second bicuspid and the first molar tooth.

Figure 302.—The upper end of this double strand of wire passing through the cheek is attached to the turnbuckle on the adjustable hook of the head cast. The adjustable hook is placed in such a position that the traction wire does not produce lateral pressure on the soft tissues of the cheek in any direction; this prevents development of a linear scar in the cheek.



Fig. 303.—Text on page 541.

Traction Wires Inserted through the Soft Tissues, Directly into Bony Fragments (Figs. 303 to 311 Inclusive)

Immobilization of an edentulous mandibular fragment by the use of a traction wire inserted directly into the fragment and fixed to a plaster head cast is necessary in the treatment of some fractures near the angle and for fixation in some bone graft operations. The most common site for insertion of such a traction wire is at the angle of the mandible, where the wire is needed for fixation of a ramus which is separated from the remaining portion of the mandible either because of a fracture near the angle or because of actual loss of bone (fig. 303). If the ramus is drawn forward by muscular traction, in certain situations, which have been discussed elsewhere in the text, use of a traction wire is the only available means of immobilization of the ramus.

The technic of surgical exposure of the angle of the mandible, and of insertion of a wire directly into the ramus, is illustrated and described chronologically in the following pages. This technic demands a most rigid form of aseptic surgery to obviate the possibility of infection and necrosis of bone.

METHOD OF INSERTING TRACTION WIRE INTO ANGLE OF MANDIBLE

Details.—Once again, the technic can be grasped most easily by consulting the illustrations along with the accompanying text.



Fig. 303.—Text on page 541.

Figure 304.—In the case illustrated in this figure, a traction wire is to be inserted near the left angle of the mandible. A head cast has been applied, in which has been incorporated a hook which emerges in the left mastoid region; to this hook, the traction wire will be attached. Surgical exposure of an angle of the mandible can be performed under local or general anesthesia; we prefer nitrous oxide. oxygen and ether administered through an intratracheal tube. as illustrated.

Figure 305.—The skin over the lower part of the face is thoroughly cleansed and the face is draped with sterile towels. To facilitate incising the skin at the proper level, the position of the left angle of the mandible is outlined by means of an indelible pencil or a skin pencil

Fig. 304.—Text on page 543.



Fig. 305.—Text on page 543.

Figure 304.—In the case illustrated in this figure, a traction wire is to be inserted near the left angle of the mandible. A head cast has been applied, in which has been incorporated a hook which emerges in the left mastoid region; to this hook, the traction wire will be attached. Surgical exposure of an angle of the mandible can be performed under local or general anesthesia; we prefer nitrous oxide, oxygen and ether administered through an intratracheal tube, as illustrated.

Figure 305.—The skin over the lower part of the face is thoroughly cleansed and the face is draped with sterile towels. To facilitate incising the skin at the proper level, the position of the left angle of the mandible is outlined by means of an indelible pencil or a skin pencil



Fig. 306.—Text on page 545.



Fig. 307.—Text on page 545.

Figure 306.—The incision is made in the skin, after which blunt dissection should be employed, so that fibers of the facial nerve will not be severed in the soft tissues. Such dissection is best carried out by employing a blunt pair of scissors or a hemostat; when the blades are spread, the soft tissues are separated rather than being cut.

Figure 307.—Blunt dissection of the soft tissues should be continued until the angle of the mandible is exposed in the wound. A blunt elevator then is employed to strip away the muscular attachments at the angle of the mandible, both on its mesial and lateral aspects.

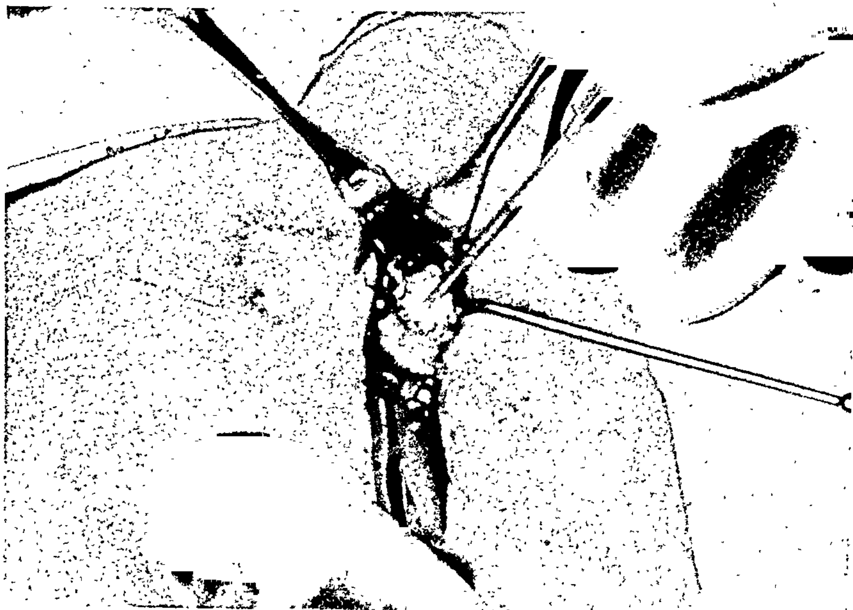


Fig. 308.—Text on page 547.



Fig. 309.—Text on page 547.

Figure 308.—Following exposure of the angle itself, a hole is made through the bone by means of a hand drill or an electrically driven drill. A broad surfaced elevator should be placed against the inner surface of the bone to prevent injury to the underlying soft tissues as the drill point passes through the bone.

Figure 309.—Three or four strands of 26 gauge bronze or stainless steel wire are inserted through the hole. Here again, brass or German silver wire should not be employed because it irritates the tissues.

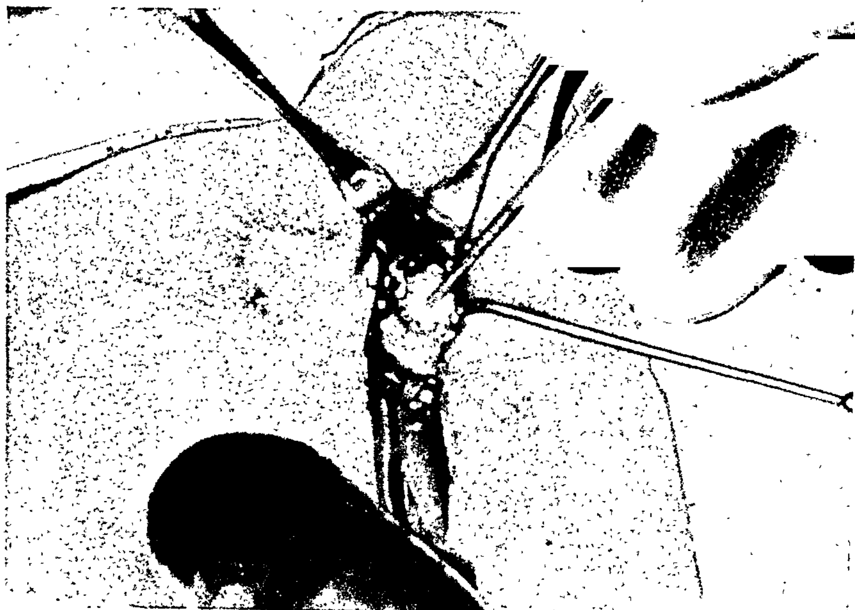


Fig. 308.—Text on page 547.



Fig. 309.—Text on page 547.

Figure 310.—The strands of wire inserted through the bone are given one complete twist to the right, close to the bone.

Figure 311.—The incision in the skin is sutured with fine silk. The ends of the wire are twisted in such a fashion that a loop of wire is formed. Into this loop rubber bands or another wire can be inserted for traction on the ramus; this rubber band or other wire extends to a hook that protrudes from the plaster head cast. The wire that has been passed through the mandible can be removed at any time without anesthesia merely by untwisting it and pulling it out of the bony fragment.

Care should be taken in this operative procedure to expose no more of the angle of the mandible than is absolutely necessary. It is to be remembered that the wire, when under tension, can pull completely through the bone in six to eight weeks. Therefore, immobilization of the posterior fragment by this method is unreliable for a longer period.



Fig. 310.—Text on page 549.



Fig. 311. -Text on page 549.

CHAPTER XII

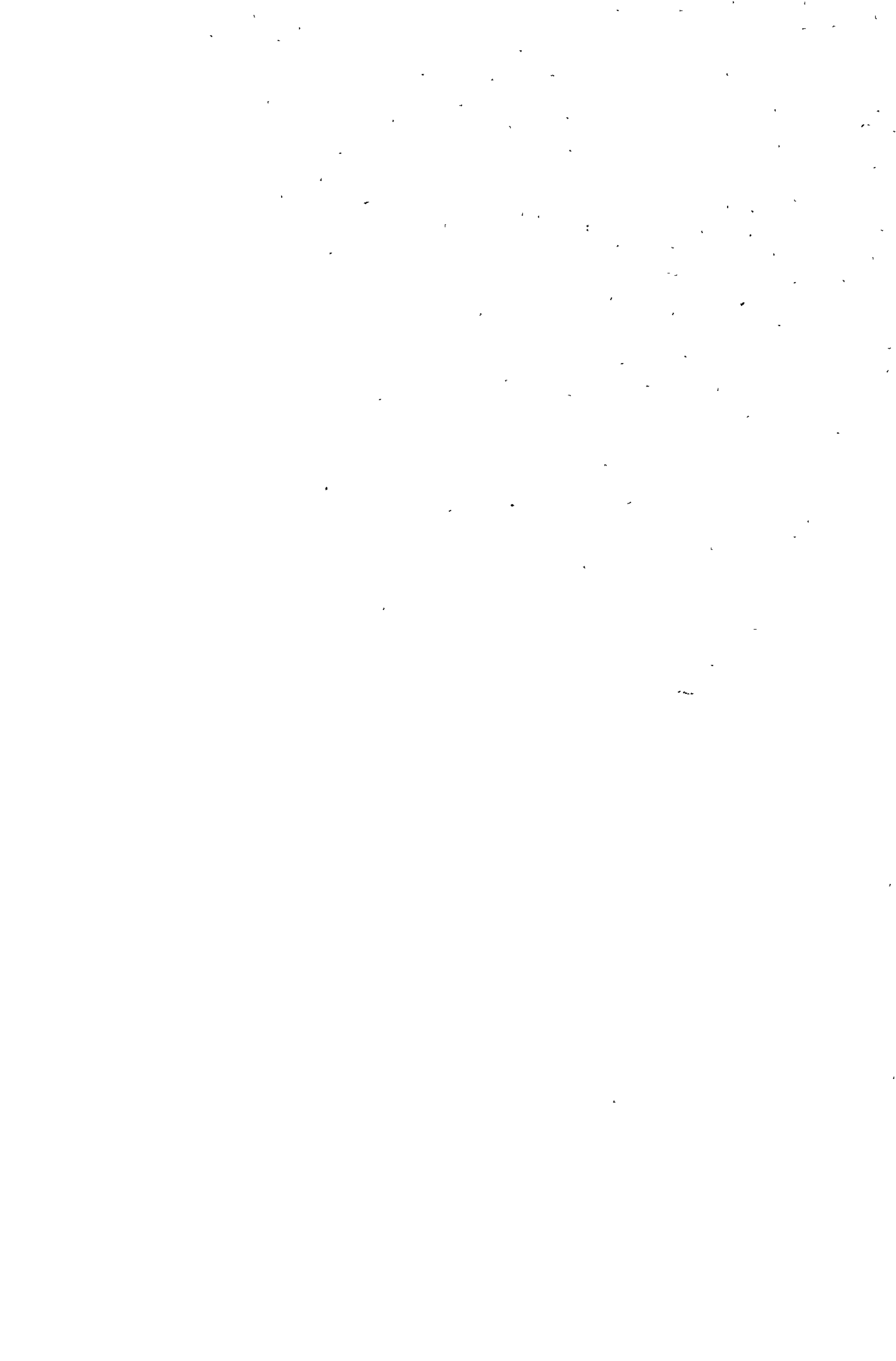
CONSTRUCTION OF DENTAL SPLINTS USED IN TRAUMATIC FACIAL BONE WORK

IN writing this chapter, we are aware that it will be of no particular interest to medical men, because construction of dental splints requires extensive training in dental prosthetics. Furthermore, we do not wish to weary our dental readers with those technical steps in construction of splints which are no different from the steps that would be required in preparation of any artificial denture or other prosthetic appliance. We merely desire to describe the various splints which, in our opinion, facilitate treatment of many injured jaws; also, to point out certain details which we have found helpful in their construction.

Although acrylic, vulcanite, and cast silver dental splints are of limited usefulness, they also are indispensable in treatment of certain injuries of the jaws. A great many splints for immobilization of fragments of the jaw have been advocated in recent years. Although a review of published descriptions of these splints is instructive, it is also likely to be somewhat confusing. Different opinions are entertained in regard to the type of splint that should be employed in treatment of various injuries of the jaws. However, for clarity in discussing this subject a classification seems highly desirable and it is possible to classify these splints in three rather definite divisions, based on their construction as well as their function. Consequently, we have grouped the splints which we employ in the following manner:

1. Acrylic or vulcanite splints.

   These are used in treatment for some fractures of edentulous jaws.



Preparation and Mounting of Dental Models (Figs. 312 and 313)

Construction of all splints described in this chapter is based on the preparation of models from dental impressions and, especially, the mounting of these models in proper relationship on a dental articulator.

Materials used in taking impressions of the alveolar ridges, or of the teeth in the bony fragments of injured jaws, may be of a plastic type, such as dental compound, which is softened by heating and hardened by cooling, or of an elastic (hydrocolloidal) type, such as dentocol. In cases of severe fracture of the jaws, impressions in dental compound of the occlusal half or third of the teeth can be obtained without too much difficulty. It has been our experience, on the other hand, that hydrocolloidal impressions seldom can be obtained because the marked displacement of the fragments, together with the intra-oral swelling and limited mobility of the jaws, prevents proper introduction, seating and removal of the trays which convey the hydrocolloidal material into the mouth. Hydrocolloidal impressions can be obtained after swelling and limitation of motion have subsided. That, however, implies a wait of two weeks or longer, which is too long if a fracture of the jaw is to be dealt with in the usual way. This then, in our practice, relegates hydrocolloidal impressions to use, almost entirely, in cases in which a bone graft is contemplated.

2. Cast silver sectional (divided) splints.
   These are used, except in one or two situations, for immobilization of dentulous fragments of some mandibles which require bone grafts.

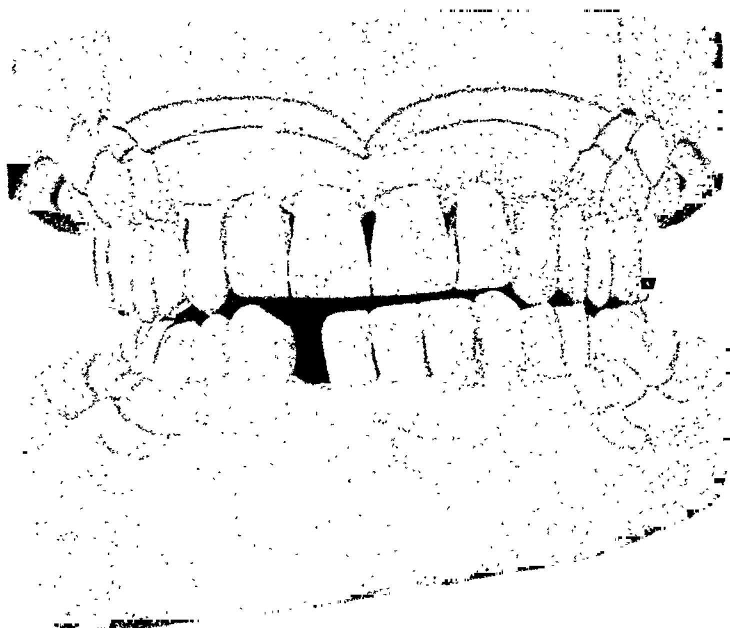


Fig. 312.—Text on page 553.

3. Cast silver one-piece splints.
   These can be subdivided as follows:
   a. Occlusal splints used for fixation of the fragments of certain fractured jaws.
   b. Bite splints used in the care of multiple fractures of both jaws, of which all fragments are displaced.
   c. Flange splints used for retaining the normal relationship of some mandibular fragments with the upper dental arch.
   d. Splints used for immobilization of intra-oral skin grafts.

Models in plaster, stone or investment compound, which are prepared from the dental impressions and on which the wax models for the splints are constructed, must be divided at the site of the fracture or fractures and must be mounted in proper relationship on a dental articulator. This technical process can be illustrated by a simple case of fracture of the lower jaw in the right cuspid region (fig. 312). The lower model is divided at the site of the fracture by means of a small hand saw (fig. 313). Next, the two resultant lower fragments are manipulated so as to articulate with the upper dental arch and are retained in proper position by joining them together with small pieces of wood and dental sticky wax (fig. 313). Finally, the models are mounted on the arms of an articulator by means of plaster. The technic of sawing through and mounting models of severely fractured jaws has been discussed and illustrated in detail in chapter VII, pages 305 to 321.

What material the model is made of depends on the type of splint to be constructed. The wax patterns for acrylic splints should be made on stone models; those for sectional silver splints, on investment material models, and those for one-piece silver splints, on plaster or stone models.

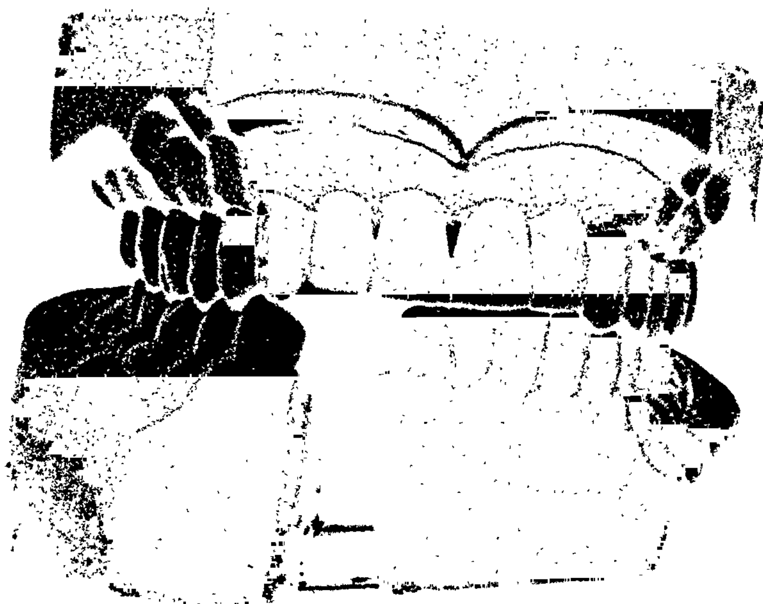


Fig. 313.—Text on page 555.

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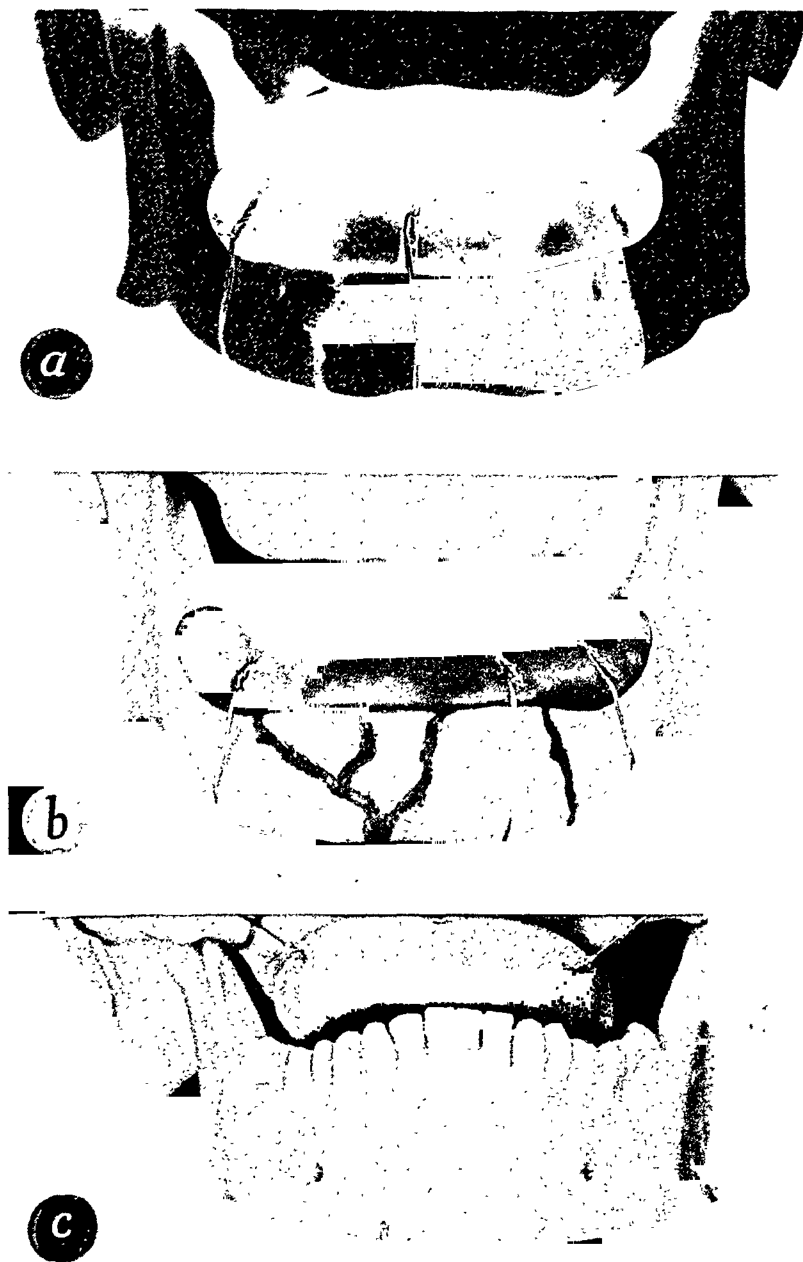


Fig. 314 *a*, *b* and *c*.—Text on page 557.

Acrylic Splints (Figs. 314 and 315)

As will be discussed in the section on sectional (divided) splints in this chapter, we have not found acrylic divided splints as satisfactory as those cast in silver. Consequently, use of acrylic splints in our hands is limited entirely to treatment for fracture of edentulous jaws. Because acrylic substances produce considerably less irritation of tissues than does vulcanite, we have dispensed with the use of the latter material.

The splints which we employ most frequently in the care of edentulous fractured jaws are base plate types of appliances. For a fractured mandible, such splints are used in conjunction with circumferential wires for immobilization of the fragments (figs. 314 *a* and *b*). For the upper jaw, a splint of this type, when attached to a plaster head cap by means of traction wires inserted through the cheeks, immobilizes an edentulous maxilla which is completely separated from the rest of the skull (fig. 314 *c*). Details of the use of these acrylic splints in treatment of various fractures of edentulous jaws has been considered in detail in several places in the text.

Construction of these base plate types of splints requires no discussion here because they are prepared in a manner similar to that employed in construction of any ordinary full denture. The stone models on which the splints for edentulous mandibular fractures are prepared must be divided at the sites of the fractures before being mounted in proper relationship on a dental articulator, as was described in the previous section of this chapter. However, the splint shown in figure 314 *c* requires only an upper stone model, which need not be mounted on an articulator.

It is advisable to grind a shallow, transverse groove across the upper surface of base plate types of lower splints at every point where a circumferential wire is to be placed (figs. 314 *a* and *b*). This prevents lateral displacement of the wire. It is well to place at least one circumferential wire around a short fragment and at least two around a long fragment.

A third type of acrylic splint, which we but rarely employ, is the Gunning splint considered in the following pages.

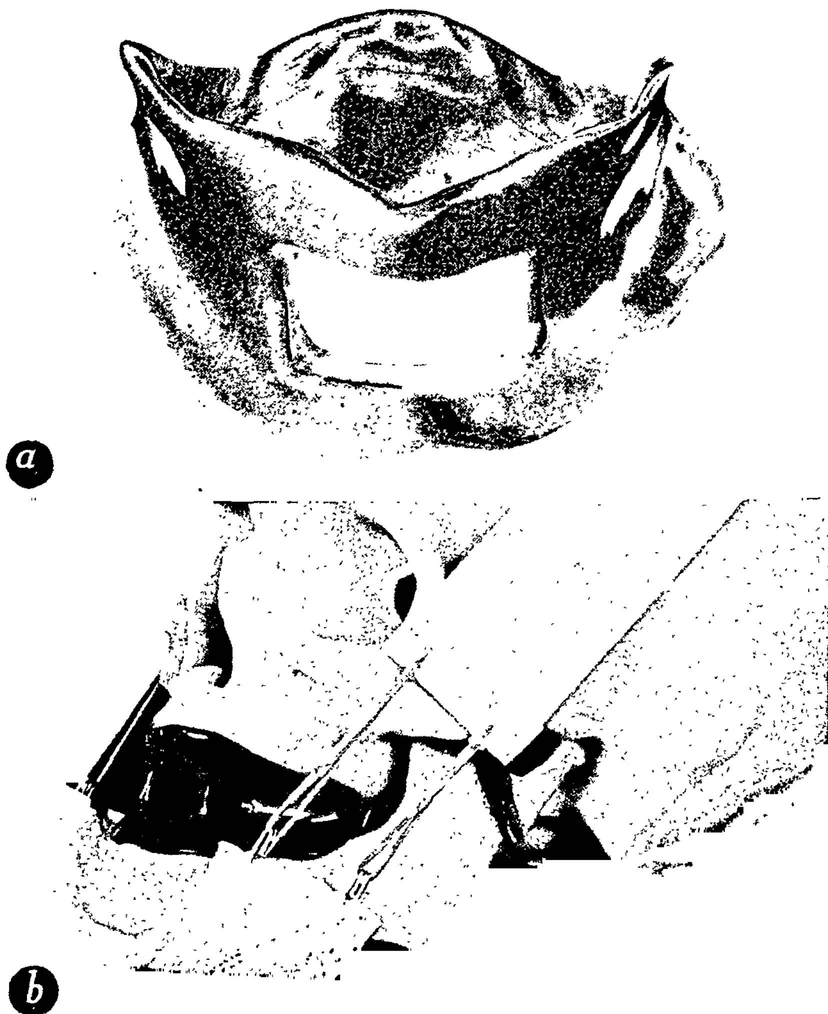


Fig. 315 a and b.—Text on page 559.

In former years, a Gunning splint (fig. 315 *a*) was employed extensively in the care of fractured edentulous jaws. However, it has been our experience that this splint does not maintain adequate immobilization of the fragments, cannot be stabilized properly and is most uncomfortable to the patient. Consequently except in the situations mentioned below, we have substituted for this splint the base plate types of splints described on page 557.

At present, we find two definite occasions for employing a Gunning splint. First, in fixation of a mandible that is displaced because of an unilateral subcondylar fracture (fig. 315 *b*) and second, for immobilization of a lower jaw that is malposed because of bilateral subcondylar fractures. In these situations, which have been discussed thoroughly elsewhere in the text, there is no better available method of fixation for the mandible. Here again, discussion of the construction of a Gunning splint is unnecessary. The stone models on which the wax pattern for this splint is prepared should be alined in proper relationship on a dental articulator.

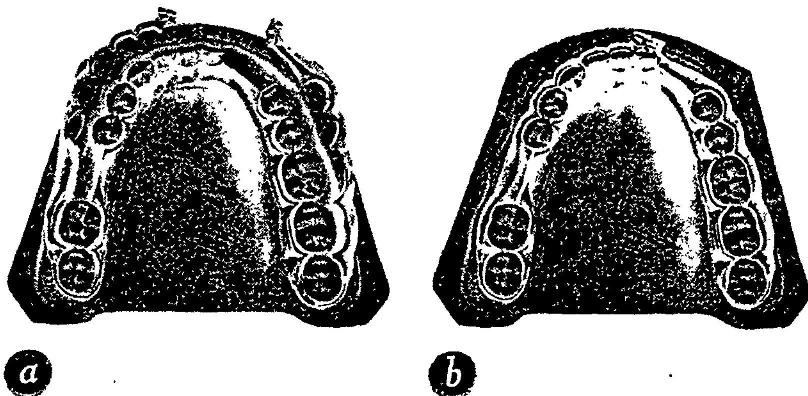


Fig. 316 *a* and *b*.—Text on pages 561 and 563.



Fig. 317.—Text on pages 561 and 563.

SECTIONAL (DIVIDED) DENTAL SPLINTS (FIGS. 316 TO 323 INCLUSIVE)

(Note: Any splint designed to immobilize dentulous fragments of an injured jaw is useless unless the fragments occupy normal relationship or unless they can be manually forced into correct alinement.)

A sectional (divided) dental splint is an appliance designed to immobilize bony, dentulous fragments of some injured jaws. It consists of two or three distinct parts, that is; a lingual segment and one or two buccal segments (figs. 316 and 317). These segments are joined together by half-round, clasp-wire hinges posteriorly and a wire ligature anteriorly, or by wire ligatures alone. If properly constructed, these splints retain the bony fragments in proper relationship without use of cement. Such splints depend for retention not on the use of cement but on the grip of the appliance in the interproximal spaces, a factor which necessitates faultless adaptation of the splint to the teeth. In order that a splint can be constructed to meet this requirement, it is essential that a perfect dental impression be secured through the use of an elastic hydrocolloidal material such as dentocol.

Sectional splints are ideal appliances because they can be conveniently and readily removed and replaced for cleansing of the mouth, teeth and splint; moreover, because they do not cover the occlusal surfaces they do not interfere with dental occlusion. However, the exactness of technic required in their construction precludes the possibility of using them in treatment of most fractured jaws where a splint is desirable. The difficulty in making such splints for fractured jaws is attributable to three factors: the displacement of the fragments, the intra-oral swelling and the limited mobility of the jaws. All of these prevent proper introduction, seating and removal of the trays which are required to carry a hydrocolloidal impression material into the mouth. Consequently, use of sectional splints, in general, must be confined to immobilization of fragments of suitable mandibles injured some time before, which demand a long period of fixation or which require a bone graft to re-establish their continuity. In these situations, there is no intra-oral swelling and, in most cases, no limitation of maxillary movement to interfere with the mechanics of obtaining a satisfactory hydrocolloidal

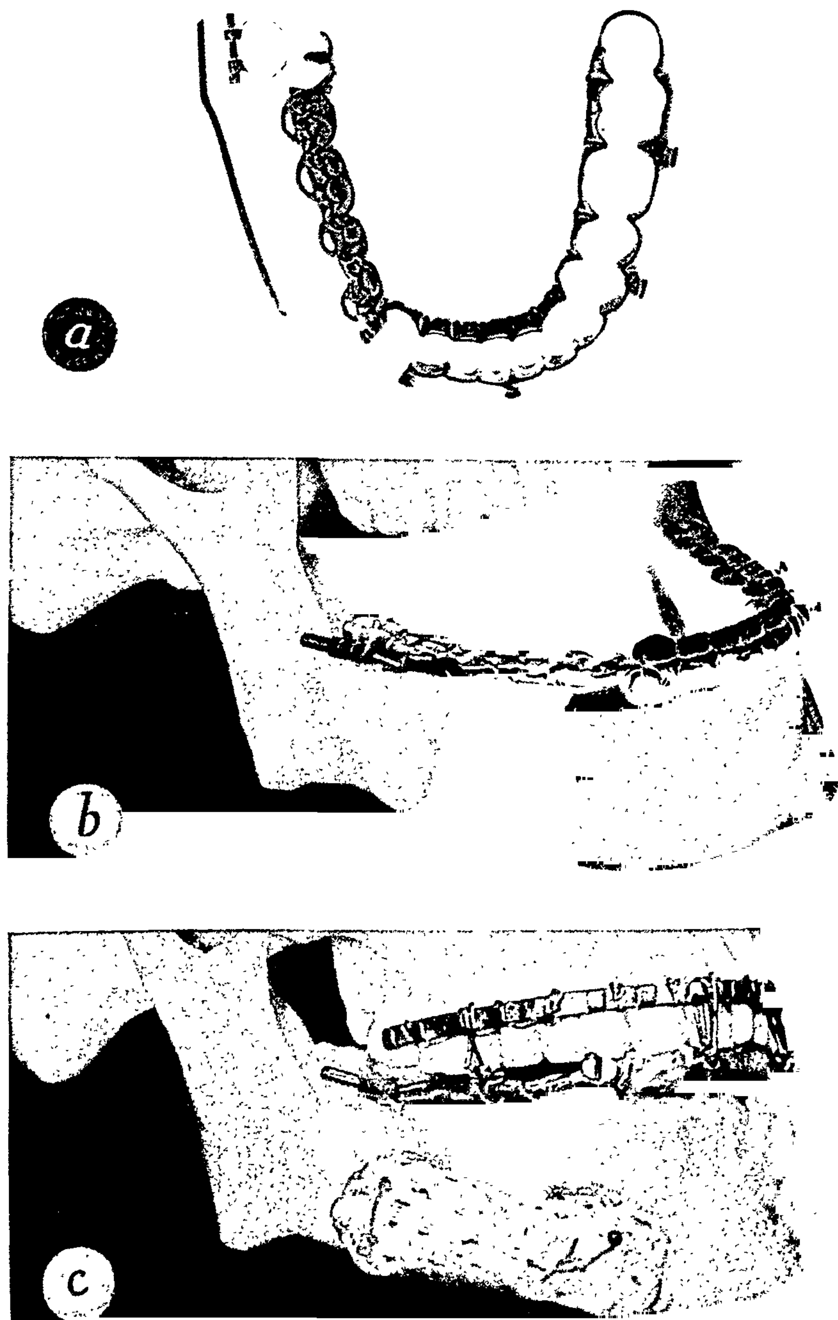


Fig. 318 *a*, *b* and *c*.—Text on pages 563 and 564.

Sectional splints can be cast in silver or can be made of one of the acrylic materials. Contrary to the opinion of many surgeons, we consider that acrylic divided splints are somewhat bulky, often lack sufficient strength, and do not always retain adequately various attachments which are incorporated in the splint. However, silver splints, even though thin, possess sufficient strength and will securely hold all appliances. Consequently, in general, we favor the use of cast silver splints. One part of copper when added to nine parts of pure silver produces an alloy of sufficient rigidity to meet the essential requirements of any metal splint.

We employ two types of cast silver sectional splints:

1. The type of sectional splint illustrated in figures 316 *a* and *b* and in figure 317 is designed to immobilize the two bony fragments of an injured jaw, each fragment containing several teeth. The buccal portion of this splint is split at the site of the labial button into two segments. The lingual and buccal segments of the splint are joined together posteriorly on each side by half round clasp wires acting as hinges. These hinges permit of separation of the buccal segments so that the splint can be seated around the teeth in both fragments. By passing a wire ligature around the divided button, the buccal segments are drawn and fixed together, and, in turn, the entire splint is securely attached to the teeth. This splint covers the gingival and middle thirds of the crowns of the teeth, leaving the occlusal thirds exposed for articulation.

The essential purpose for which we employ this splint is immobilization of the fragments of an injured jaw when a bone graft is required (fig. 317).

In rare instances, this type of splint can be employed for fixation of an unilateral fracture of the uper jaw in which there is no displacement of the loose fragment. See Problem 30, page 195.

Construction of this splint is described on pages 565 to 567.

2. When but one or two posterior teeth are present in one fragment, the splint illustrated in figure 316 *a* and *b* does not offer adequate fixation for this fragment. Consequently, we have devised a sectional splint (fig. 318 *a*) to meet the problem of immobilization of fragments under these circumstances.

This splint possesses a lingual and a buccal segment to fit around the teeth of the long dentulous fragment. The portion which spans the edentulous region of the lower jaw possesses

multiple loops on its buccal margin and a lingual rest for a tooth at the distal extremity of the short fragment. An anchor clamp band, having a buccal sheath, is applied to this tooth in the short fragment. A brass rod, inserted in the sheath of the anchor band and wired to the buccal loops on the silver splint, firmly fixes the splint and band together and, in turn, immobilizes the bony fragments. The divided button, around which a wire liga-

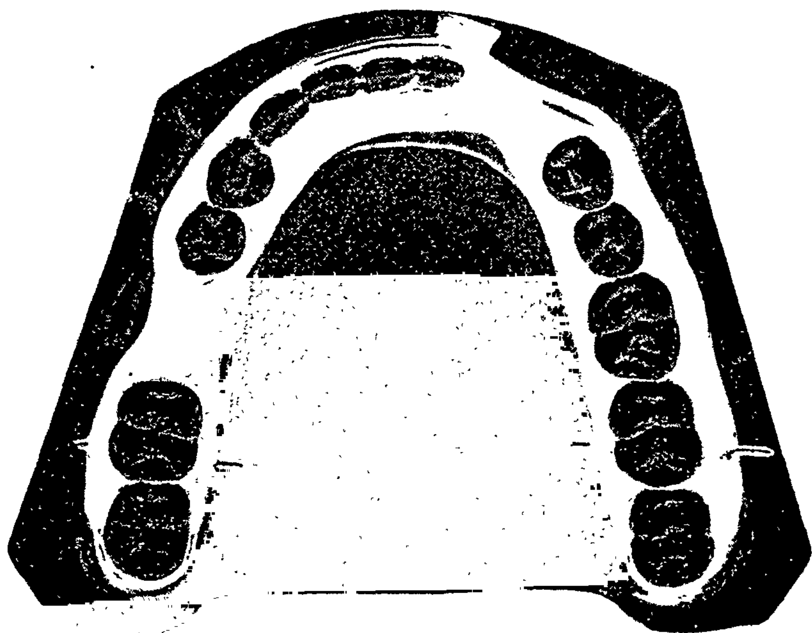


Fig. 319.—Text on page 565.

ture is twisted, can be seen at the anterior extremity of the buccal segment (fig. 318 *a*).

This type of splint offers an excellent means of maintaining the normal relationship of the bony fragments of a mandible which is defective in the bicuspid or first molar region; fixation in normal relationship is essential for several months prior to insertion of a bone graft (fig. 318 *b*). Furthermore, this splint offers absolute fixation for the fragments during the period of healing of the bone graft (fig. 318 *c*).

TECHNIC OF CONSTRUCTION OF CAST SILVER SECTIONAL SPLINT FOR MANDIBLE WITH SEVERAL TEETH IN BOTH FRAGMENTS (FIGS. 319 to 322 Inclusive)

This splint, described on page 563 (figs. 316 and 317), is constructed as follows:

1. Obtain a hydrocolloidal impression of the teeth in the upper and lower jaws.
2. Prepare, from each impression, one model in any good investment material. It is essential that the lower model be made of investment compound so that the molten metal can be cast directly over the model.
3. Saw through the lower model at the site of the defect of the mandible, as is described on page 555.
4. Mount the fragments of the lower model and the upper model on an articulator in correct occlusion. Duplicate the mounted lower model in stone. It always is advisable to have a master model in stone on which the finished silver splint can be fitted and adjusted.
5. Construct a hinge on each side, using half round clasp wire for this purpose. These wires should be adapted to the buccal, distal and lingual surfaces of the last tooth to be included in the splint on each side. The free ends of these wires should be carried forward over the next tooth anteriorly and bent out at right angles for a distance of about 1 cm. The anterior half of each wire hinge is incorporated in the wax pattern. The bent out ends engage the investment material, which is applied later, and maintain the hinge in correct position during the casting process (fig. 319).
6. Prepare a wax pattern for the silver splint. For this purpose we prefer to use blue inlay wax, which is applied directly to the gingival and middle thirds of the teeth in the model (fig. 319). If the finished splint is to be used in conjunction with intermaxillary wiring, buttons, hooks or loops, to which such wires will be attached, should be prepared in wax and attached to the wax pattern. Anteriorly, a flat, good sized, wax button should be attached to the labial portion of the wax pattern (fig. 319).
7. Several wax sprues of generous size are applied to the wax pattern.
8. Remove the model with the completed wax pattern from



Fig. 320 —Text on page 567.

the articulator and complete the investment in a ring of suitable size.

9. Care should be taken to insure complete elimination of wax from the investment.

10. Cast the splint in an alloy of silver, as previously described (fig. 320). Remove the sprues and polish the splint before dividing the buccal and lingual portions and before splitting the button to separate the anterior portion into two segments.

11. Apply the finished splint to the master model for final adjustments (figs. 321 and 322).

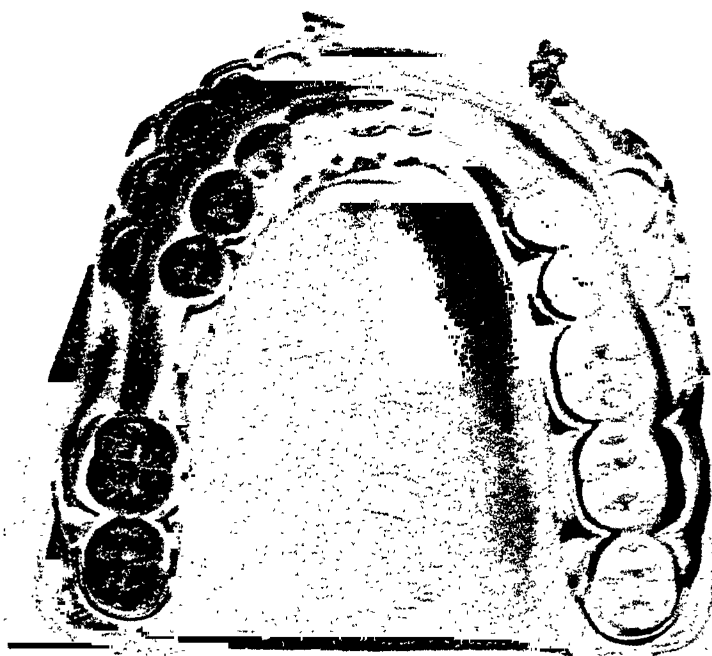


Fig. 321.—Text on page 587.

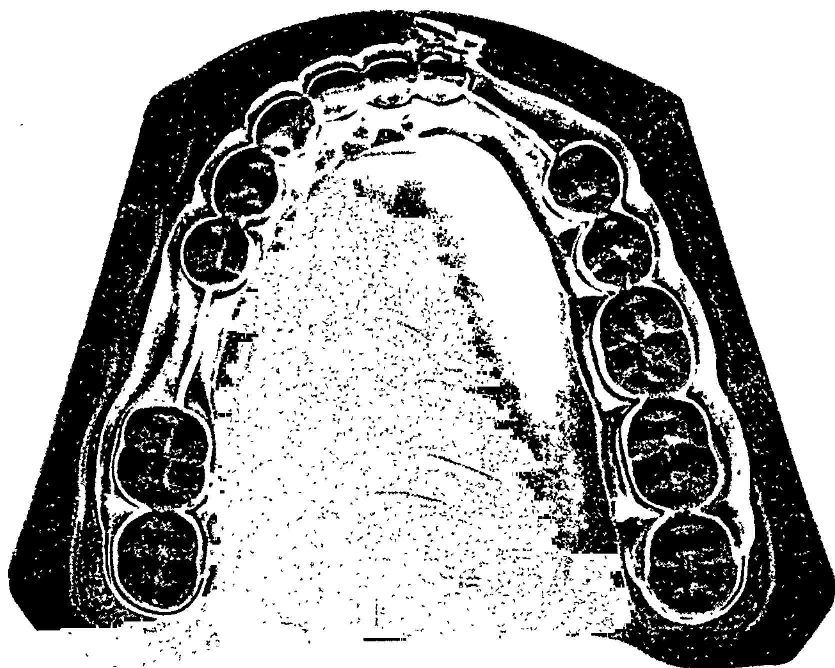
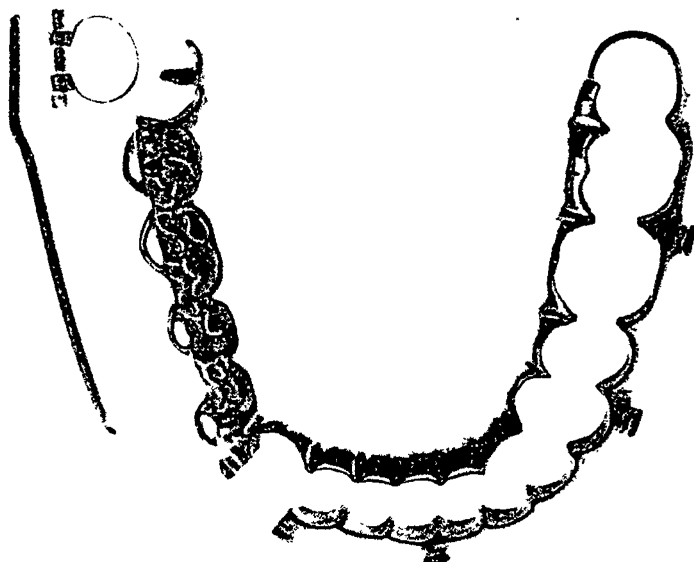


Fig. 322.—Text on page 567.



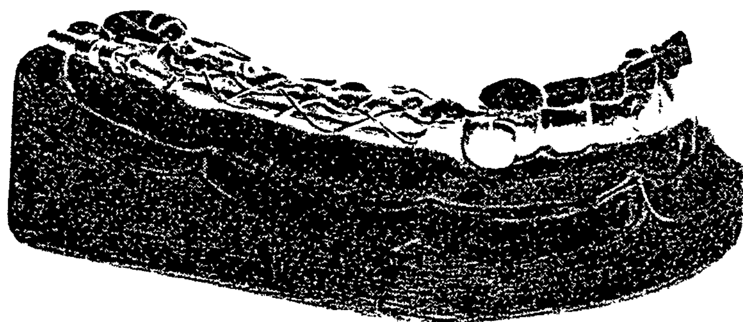


Fig. 323 *a* and *b*. Text on page 571.

TECHNIC OF CONSTRUCTION OF CAST SILVER SECTIONAL SPLINT FOR MANDIBLES WITH ONLY ONE OR TWO POSTERIOR TEETH IN ONE FRAGMENT (FIG. 323 a and b)

This splint was described on page 563 (fig. 318). Its construction fundamentally is no different from that of the splint just described on pages 565 and 567.

The undivided portion of the splint, which spans the edentulous region of the lower jaw (fig. 323 *a*), should not impinge on the underlying soft tissues and should possess a series of loops along its buccal margin.

The rod which joins the anchor band and silver splint together should be bent to fit into the buccal sheath of the band and under the loops on the casting. The anterior end of this rod should be bent upward at a right angle to engage the loop situated most anteriorly; this prevents anteroposterior displacement of the rod. This rod is attached to the loops of the casting by a strand of 26 gauge wire, as is illustrated in figure 323 *b*.

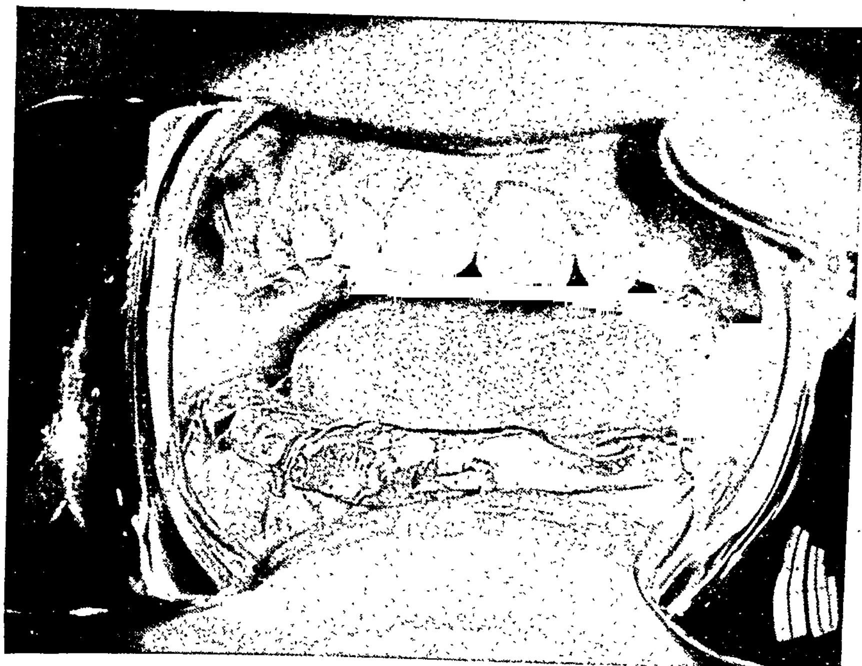


Fig. 324.—Text on page 573.

Silver Dental Splint (Figs. 324 to 333 Inclusive)

Any splint designed to immobilize the dentulous frag-
n injured jaw is useless unless the fragments occupy
ationship or unless they can be manually forced into
ement.)

ece dental splint, just as is true of a sectional splint,
ance designed to immobilize the bony fragments of
ed jaws. While the sectional splint is so perfectly
the contour of the teeth that it must be made in a
anner in order to be applied, the one-piece splint is
adapted that it can be readily slipped into position
eeth. Consequently, a one-piece splint must be con-
a model made from an impression in dental com-
h a model possesses no undercuts to interfere subse-
th seating of the finished splint. Most one-piece splints
cement for retention to the teeth; others depend on
ntial or some other form of wiring (fig. 324).

e splints are not always ideal, because they cover all,
portion, of the occlusal surfaces of the teeth and may
ith dental articulation. However, they are applicable
cases of fracture of the jaws in which it is impossible
a satisfactory hydrocolloidal impression but in which
s in dental compound can be secured. Furthermore,
certain unusual types of metal splints, designed for
purposes, which must be constructed in one piece
ey require cement for attachment to the teeth.

of review we wish to say here, that the cast silver,
dental splints which we employ are:

sal splints, used for fixation of the fragments of cer-
n fractured jaws.

splints, used in the care of multiple fractures of both
vs, in which there is displacement of all the fragments.
ge splints, used for retaining the normal relationship of
ne mandibular fragments with the upper dental arch.
its for immobilization of intra-oral skin grafts.

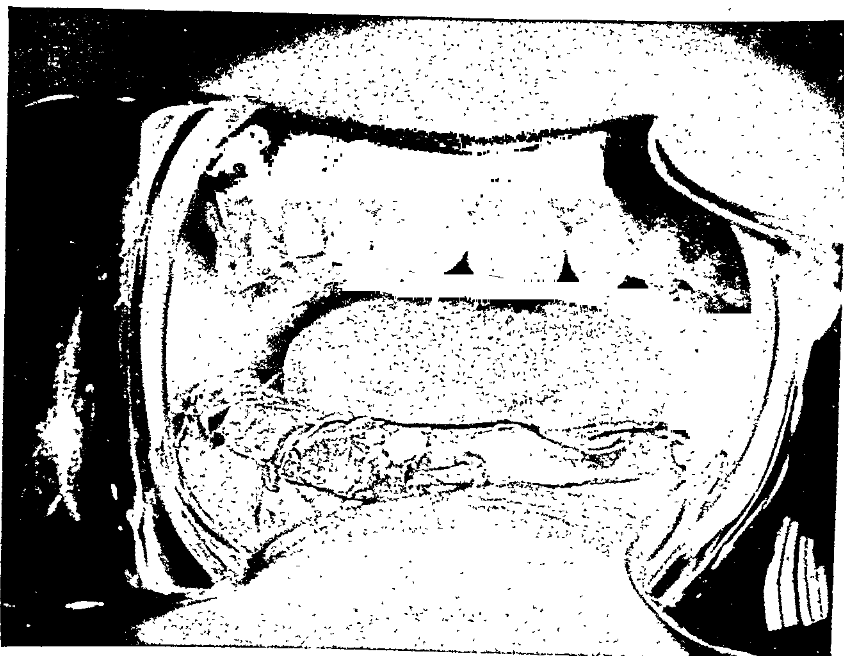


Fig. 324.—Text on page 573.

OCCLUSAL ONE-PIECE SPLINTS FOR FIXATION OF FRAGMENTS OF CERTAIN FRACTURED JAWS (FIGS. 325 to 328 Inclusive)

One of the simplest and most effective one-piece cast silver splints which we employ is the type illustrated in figure 325. It is used for immobilization of the fragments in cases of fracture of the body of the mandible in young children. Circumferential wires rather than cement are needed for fixation of this splint. The steps in its construction are as follows:

1. In dental compound obtain an impression of the upper and lower dental arches.
2. Prepare from each impression a stone model.
3. Saw through the lower model at the site of the fracture.
4. Mount the models in proper relationship on a dental articulator.
5. Prepare a wax pattern for the silver splint. Adapt a sheet of 28 gauge casting wax over the exposed surfaces of the teeth on the lower model. It is well not to carry the wax to the gingival margin. Since there may be one or more undercuts on the model, the wax pattern should be withdrawn from the model at frequent intervals during construction to make certain that the pattern will not be distorted on final removal. Blue inlay wax should be applied to give the necessary bulk and rigidity to the pattern. In the particular case illustrated in figure 325, wax loops should be applied to the buccal and lingual margins of the pattern; these loops serve as attachments for circumferential wires and obviate the necessity of carrying the wires over the occlusal surface of the splint to interfere with occlusion.
6. The pattern is sprued, invested and burnt out in the usual manner.
7. The splint is cast in silver (one part copper to nine parts pure silver) and polished.

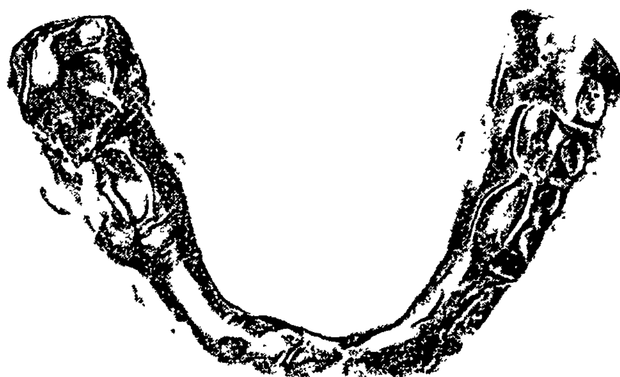


Fig. 325.—The two lingual marginal loops and one buccal marginal loop are not plainly visible in the photograph. Text on page 575.

All of the one-piece cast silver splints, which we employ in treatment of certain fractured jaws, and which have been described in the previous chapters, are constructed basically the same as the silver splint for children described on page 575. Some of them, employed in conjunction with intermaxillary wires, require construction of buttons, hooks or loops on the buccal surfaces of the wax patterns.

When but one or two teeth remain in one fragment, the splint is made to fit over the teeth in the long dentulous fragment, with an extension across the edentulous region, and with a lingual rest on one of the teeth in the short fragment. The splint immobilizes the two fragments of the jaw by its attachment to an anchor clamp band placed over a tooth in the short fragment, as was described for the sectional splint on page 571. This one-piece splint is retained over the teeth in the long fragment, either by the use of cement or circumferential wires (fig. 326 *a*). This type of splint is used essentially for fixation of fragments of the lower jaw when there is an associated unilateral fracture of the upper jaw (fig. 326 *b*).

One-piece cast silver splints often can be constructed with saddles for fixation of edentulous fragments. Such splints are represented in figures 327 *a*, *b* and *c* and 328 *a* and *b*; their purpose, which is evident in the illustrations, has been discussed fully in the preceding chapters on fractures of the jaws.

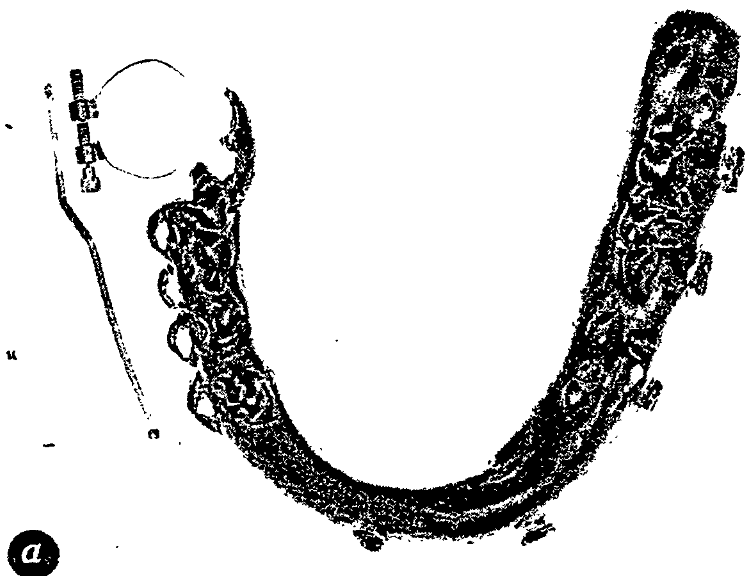




Fig. 326 *a* and *b*.—Text on page 577.

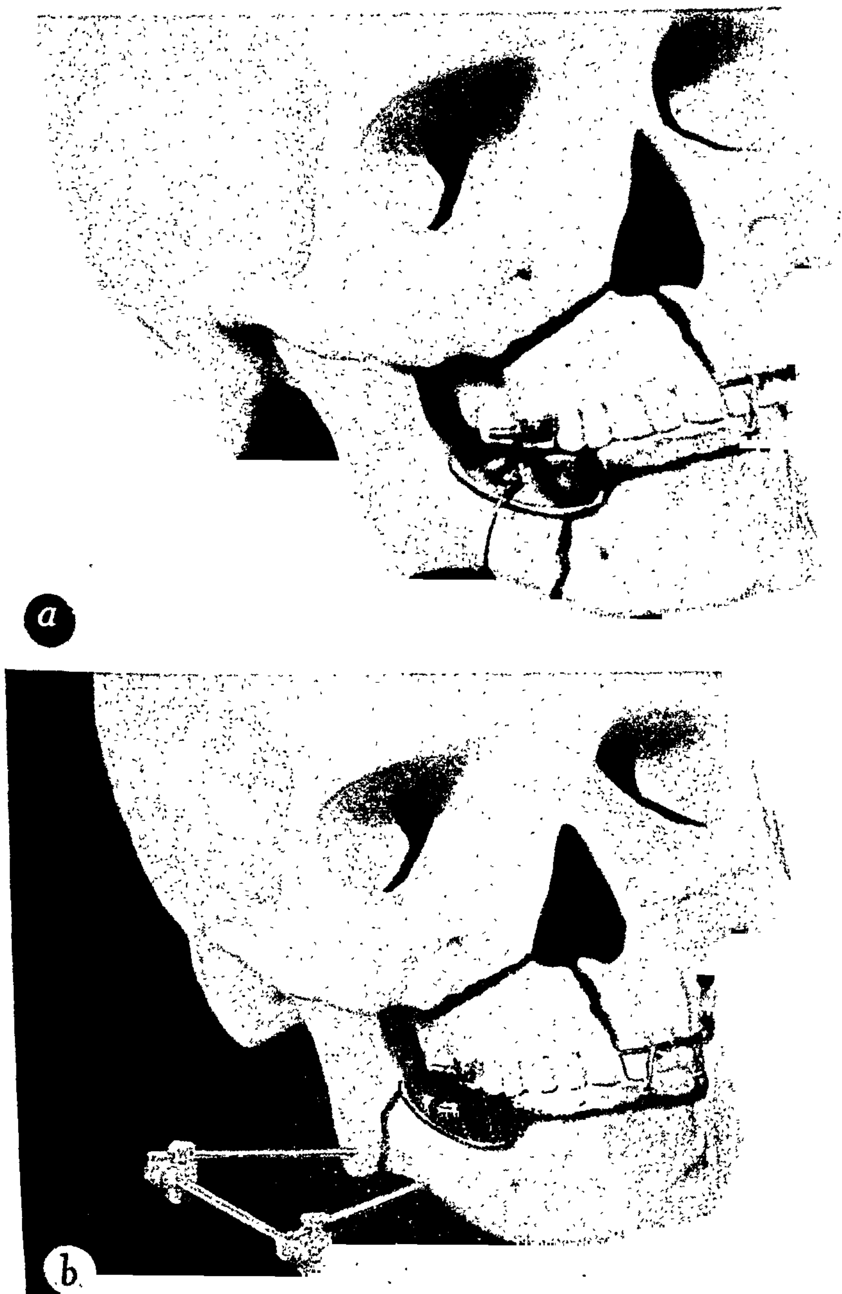


Fig. 328 *a* and *b*.—Text on page 577.

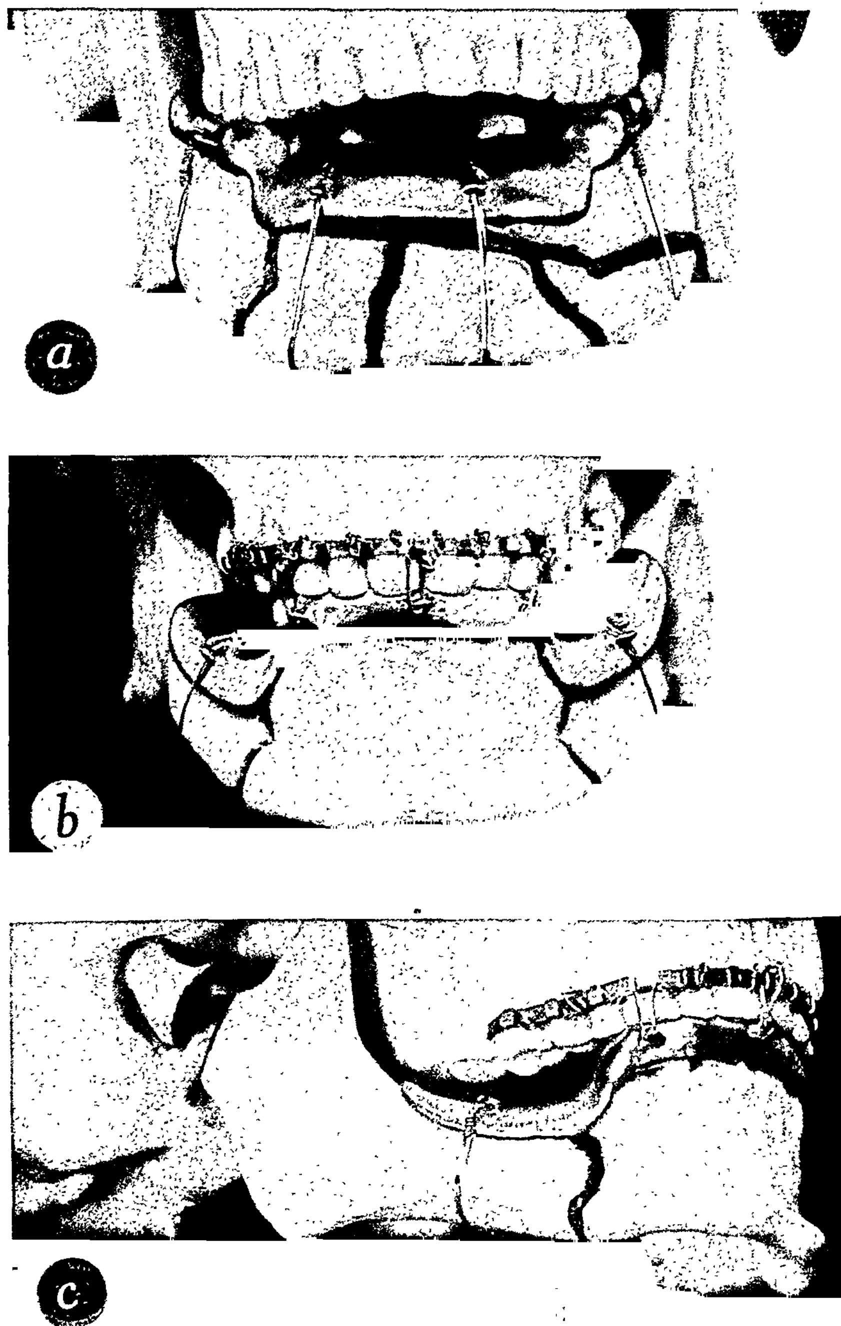


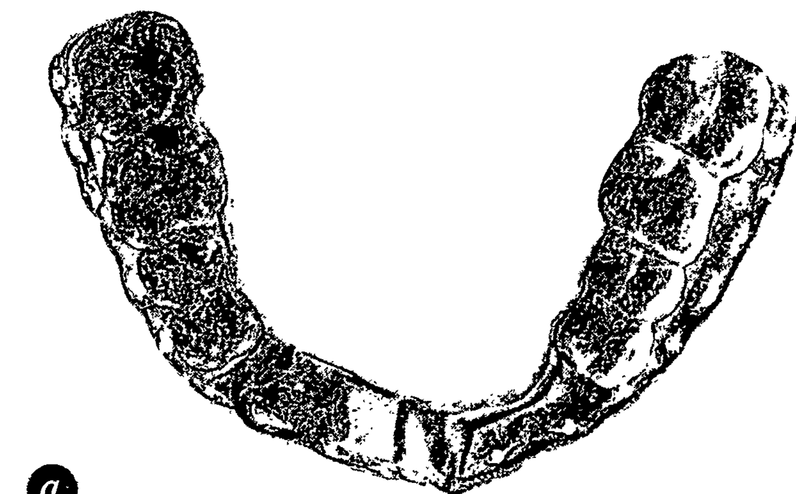
Fig. 327 *a*, *b* and *c*.—Text on page 577.

BITE SPLINT USED FOR MULTIPLE FRACTURES OF BOTH JAWS (FIG. 329 a and b)

The most important operation in construction of a bite splint, which is employed in treatment of multiple fractures of the jaws, is the preparation, cutting and mounting of stone models. This technic has been discussed in detail in chapter VII, pages 305 to 321.

The wax pattern for this splint is made from a double layer of number 7 pink base-plate wax which, on heating, is readily eliminated from the final investment. The conformation of the wax pattern is extremely simple, as is illustrated by the finished splint (fig. 329 *a* and *b*). In its outer margin there should be multiple perforations for the attachment of various wires.

Use of this splint has been described fully in chapter VII.



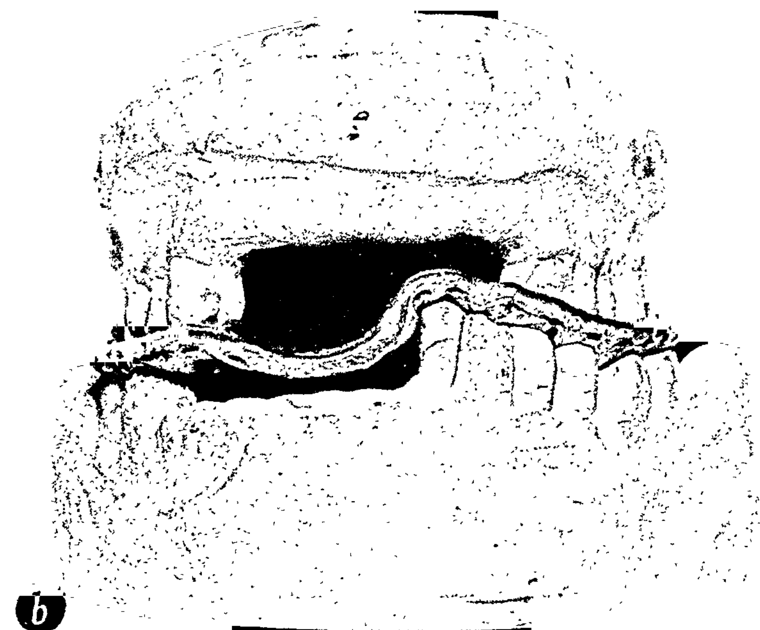


Fig. 329 *a* and *b*.—Text on page 581.

FLANGE SPLINTS (FIGS. 330, 331 and 332)

A cast silver flange splint is a full coverage appliance which is cemented to three or four posterior teeth in a dentulous fragment. It possesses a vertical flange which rides on the buccal surface of the opposing upper teeth when the patient opens or closes his mouth (fig. 330). This flange should be inclined a trifle buccally so as not to impinge on the gum tissue of the upper teeth. Moreover, the flange should be made as long as possible without encroaching on the upper alveolobuccal fold of mucous membrane; the longer the flange, the less chance there is for the device to become disengaged from the upper teeth on opening of the patient's mouth.

The construction of this splint basically is not different from that described on page 575 for an occlusal, one-piece, cast silver splint.

The purpose of a flange splint is to maintain the proper relationship of a long lower dentulous fragment to the upper dental arch in a case of unilateral loss either of the ramus (fig. 331) or of the posterior portion of the body of the mandible (fig. 332). The splint is used prior to restoration of the continuity of the lower jaw by means of a bone graft.



Fig. 330.—Text on page 583.



Fig. 332.—Text on page 583.



Fig. 331.—Text on page 583.



Fig. 332.—Text on page 583.

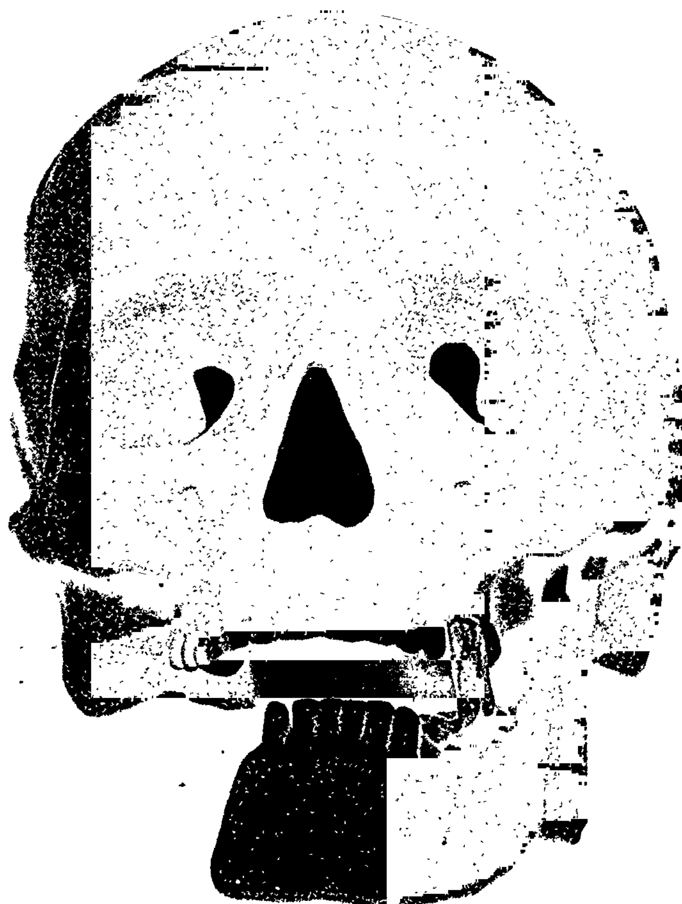


Fig. 331.—Text on page 583.

SPLINT FOR IMMOBILIZATION OF INTRA-ORAL SKIN GRAFT (FIG. 333)

This splint is a full coverage, one-piece, cast silver appliance, which offers perfect immobilization for intra-oral skin grafts.

Construction of the splint itself is similar to that of any one-piece silver splint, as is described on page 575.

On the labial surface, in the regions where screws are to be inserted (fig. 333), the wax pattern of the splint should be built out to a thickness of about 3 mm.

After the splint has been cast in silver, holes are drilled through these thickened portions of the splint. By means of a machinist's tap, which should be of the same size as the screws to be employed, the holes are threaded.

Flat headed steel screws, when inserted into these threaded holes, securely attach a supplementary wire frame that retains the mold around which the skin graft is wrapped.

The conformation of the wire frame is evident in figure 333. The frame is bent from one piece of rigid wire, although the upper cross-bar must be soldered to the two vertical arms. The free ends of the wire are formed into flattened loops for reception of the screws.

The use of this splint has been discussed fully in chapter IX, pages 429 to 439.

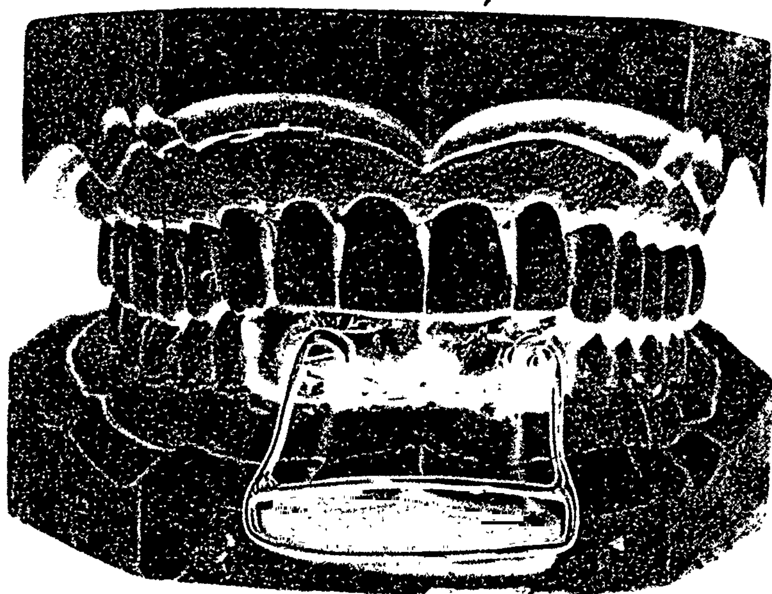


Fig. 333.—Text on page 587.

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